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हाइड्रोमीटरी — पारिभाषिक शब्दावली और प्रतीक

(तीसरा पुनरीक्षण)

Hydrometry — Vocabulary and Symbols

(Third Revision)

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Hydrometry Sectional Committee, WRD 01

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Hydrometry Sectional Committee, WRD 01 had been approved by the Water Resources Division Council.

This standard was first published in 1959 under the title 'Glossary of terms used in measurement of flow of water in open channels'. Subsequently deriving assistance from ISO/R 772 : 1968 'Glossary of terms and symbols used in connection with the measurement of liquid flow with a free surface', the first revision was published in 1971 under the modified title 'Glossary of terms and symbols used in connection with the measurement of liquid flow with a free surface (*first revision*)'. The second revision of this standard was published in 2003 under the title 'Hydrometric determination — Vocabulary and symbols (*second revision*)' wherein a great deal of assistance was derived from ISO 772 : 1996 'Hydrometric determination — Vocabulary and symbols'.

This is the third revision of this standard. This revision has been taken up to bring in further modifications/ improvements in the light of experience gained while using the earlier version of the standard. This revision has been prepared by largely deriving assistance from ISO 772 : 2011 'Hydrometric determination — Vocabulary and symbols'. However the part on groundwater has been deleted from the same and is proposed to be covered in a separate standard.

Further in this standard the following three principles as adopted in 1SO 772 : 2011 were followed, wherever possible:

a) To standardize suitable terms and symbols without perpetuating unsuitable ones.
b) To discard any term or symbol used with differing meanings and to replace that term or symbol by one which has an unequivocal meaning.
c) To exclude terms which are self-evident.

The terminology entries are presented in systematic order, grouped into sections according to particular methods of determination or in relation to particular subjects.

Annex A lists the symbols used in this standard. An alphabetical index is included at the end.

Indian Standard

HYDROMETRY —VOCABULARY AND SYMBOLS

(Third Revision)

1 SCOPE

This standard gives terms, definitions and symbols used in standard in the field of hydrometry.

2 GENERAL TERMS

2.1 Liquid Flow — Movement of a volume of a substance that is neither a solid nor a gas, that is practically incompressible, that offers insignificant resistance to change of shape and that flows freely.

Example :

Water or water with sediment.

2.2 Flow Regime — State of flow in alluvial streams characterized by a bed configuration of ripples, dunes (lower regime), plane bed (transition), standing waves and antidunes (upper regime).

NOTE — The lower-regime flow is subcritical; the upper-regime flow is supercritical.

2.3 Steady Flow — Condition in which the discharge does not change in magnitude with respect to time.

2.4 Unsteady Flow — Condition in which the discharge changes in magnitude with respect to time.

2.5 Uniform Flow — Flow, in an open channel, in which the depth and velocity remain constant along the open channel**.**

NOTE — For uniform flow, the velocity vector is constant along every stream line. Uniform flow is possible only in an open channel of constant slope and cross-section.

2.6 Critical Flow — Flow, in an open channel, in which the specific energy is a minimum for a given discharge.

NOTE — Under this condition, the Froude number is equal to unity and small surface disturbances cannot travel upstream.

2.7 Subcritical Flow — Flow in an open channel at less than critical velocity, that has a Froude number of less than unity, and in which small surface disturbances can travel upstream.

2.8 Supercritical Flow — Flow in an open channel at more than critical velocity, that has a Froude number of greater than unity, and in which small surface disturbances cannot travel upstream.

2.9 Transverse Flow, Lateral Flow — Flow horizontally perpendicular to the main direction of flow parallel to the axis of the open channel(s).

NOTES

1 Transverse (lateral) flow is frequently associated with secondary flow.

2 Transverse (lateral) flow in open channels with a curved plan form causes super elevation of the water surface at the outside of the bend.

2.10 Stratification of Flow — State of a fluid that consists of two or more layers arranged according to their density, the lightest layer being on top and the heaviest at the bottom.

2.11 Critical Depth — Depth of flow at which critical flow occurs.

2.12 Critical Velocity — Velocity at critical flow.

2.13 Channel — Course of a river, stream, or other waterway.

NOTE — The term can be qualified adjectively to describe a particular type of channel, such as a low-water channel, a main channel or an artificial channel.

2.14 Open Channel — Longitudinal boundary surface consisting of the bed and banks or sides within which the liquid flows with a free surface.

2.15 Canal — Man-made channel, usually of regular cross-sectional shape.

2.16 Stable Channel — Open channel in which the bed and the sides remain essentially stable over a substantial period of time in the reach under consideration, and in which the scour and deposition during the rising and falling stages are negligible.

2.17 Unstable Channel — Open channel that changes frequently and significantly in its plan—form and/or cross-sectional form for the reach under consideration.

2.18 Tidal Channel — Open channel in which the flow is subject to tidal action.

2.19 Tidal Waterway — One or more tidal channels together with the shallows and the banks or sides by which the water at high tide is bounded.

2.20 Estuary — Lower reaches of a river that is freely

connected with the sea and which receives fresh water supplies from upland drainage areas.

2.21 Stream — Water flowing in a natural open channel.

NOTE — By extension, this refers to moving water and the channel containing it.

2.22 Current — Liquid flow in a discernable general direction.

2.23 River — Stream of water in a natural open channel.

2.24 Alluvial River — River which flows through alluvium formed from its own deposits.

NOTE — The sediment carried by an alluvial river, except for the wash load, is similar to that in the bed.

2.25 Incised River — River which has formed its channel by a process of degradation.

2.26 Braided River — River characterized by a wide and shallow open channel in which flow passes through a number of small interlaced channels separated by shoals.

NOTES

1 Frequently, there is little or no erosion of the main banks of a braided river.

2 Generally, there is little or no meandering of the main channel of a braided river, but meandering in the minor channels is usual.

2.27 Reach — Length of open channel between two defined cross-sections.

2.28 Meandering Channel — Channel following a sinuous path, characterized by curved flow leading to bank erosion alternating with shoaling.

2.29 Dune — Large bed form having a triangular profile, a gentle upstream slope and a steep downstream slope.

NOTE — Dunes are formed in quiet flow and thus are out of phase with any water surface disturbance that they may produce. They travel slowly downstream as sand is moved across their comparatively gentle upstream slopes and deposited on their steeper downstream slopes.

2.30 Antidunes — Bed form of a curved symmetrically shaped sand wave that may move upstream, remain stationary or move downstream.

NOTE — Antidunes are curved in a wave train but they are in phase and interact strongly with gravity water surface waves.

2.31 Ripple — Small triangular-shaped bed form similar to a dune.

NOTE — Ripples have much smaller and more uniform amplitudes and lengths than dunes. Ripple wavelengths are less than 0.6 m and wave heights are less than 0.06 m.

2.32 Thalweg — Line of greatest depth, and thus the lowest water thread, along the stream channel.

2.33 Transition, Crossover — Inflection reach between two meander loops in which the main flow crosses from one side of the channel to the other.

NOTE — The depth of flow in a transition is usually reduced from normal depth and is more uniform than in the curved reach.

2.34 Node, Nodal Point, Inflection Point — Point in a transition at which the sinuous path crosses the mean axis of the meander system.

NOTE — In a meandering stable channel, the node migrates downstream with the meander loops. Migration can be prevented by the creation of a natural or artificial obstruction in the channel.

2.35 Discharge, Q —Volume of liquid flowing through a cross-section in a unit time.

NOTE — This term is not synonymous with flow.

2.36 Unit Discharge, Discharge per Unit Width, qu —Discharge through a unit width of a given vertical section.

2.37 Specific Discharge (in relation to area), Q — Discharge per unit area of catchment or aquifer.

2.38 Specific Discharge (in relation to stage), q — Discharge corresponding to a specific stage or to a specific gauge height.

2.39 Stream Gauging — All of the operations necessary for the measurement of discharge of a stream.

2.40 Discharge Measurement — Process of measuring the discharge of liquid in an open channel.

2.41 Gauge — Device installed at a gauging station for measuring the level of the surface of the liquid relative to a datum.

2.42 Velocity — Speed of flow past a point in a specified direction.

2.43 Speed (of flow) — Ratio of the distance covered by a body of water, moving in a specified direction, to the time taken to cover that distance.

2.44 Left Bank — Bank to the left of an observer looking downstream.

2.45 Right Bank — Bank to the right of an observer looking downstream.

2.46 Invert — Lowest part of the cross-section of a natural or artificial channel.

2.47 Bed Slope, Bottom Slope, S — Difference in elevation of the bed per unit horizontal distance, measured in the direction of flow.

NOTE — The slope is usually mathematically negative in the direction of flow.

2.48 Bed Profile — Shape of the bed in a vertical plane.

NOTE — The shape of the bed may be considered longitudinally or transversely; this should be stated.

2.49 Side Slope — Ratio of the horizontal to the vertical components of the bank slope, unless otherwise stated.

2.50 Surface Slope — Difference in elevation of the surface of the stream per unit distance, measured in the direction of flow.

2.51 Surface Drawdown — Local lowering of the water surface in an approach channel, caused by acceleration of the flow passing over an obstacle or through a control.

2.52 Fall, Canal Fall — Difference in elevation of the water surface between the extremities of a defined reach at a given instant of time, for example as recorded at a twin-gauge station.

2.53 Top Width — Width of the open channel measured across the stream at the water surface normal to the direction of flow.

2.54 Wetted Perimeter, *P*w — Contact length between a stream of flowing water and its containing open channel, measured in a direction normal to the flow.

2.55 Cross-section (of a stream) — Section normal to the mean direction of flow bounded by the free surface and wetted perimeter of the stream.

2.56 Gauging Section, Measuring Section — Section at which discharge measurements are taken.

2.57 Measuring Reach — Reach of open channel selected for measurement of hydraulic parameters.

2.58 Converging Reach — Reach in which the cross-sectional area gradually decreases in the direction of flow.

2.59 Expanding Reach — Reach in which the cross-sectional area gradually increases in the direction of flow.

2.60 Flood Mark, Trash Line, Debris Line — Traces of any kind left on the banks or obstacles or flood plain by a flood.

NOTE — The flood mark may be used to determine the highest level attained by the water surface during a flood.

2.61 Normal Velocity Distribution — Velocity distribution in a straight open channel of uniform cross-section and constant slope which is of sufficient length to develop uniform resistance-controlled flow.

2.62 Surface Velocity — Velocity of a liquid at its surface at a given point.

2.63 Mean Velocity Depth — Depth below the surface at which the mean velocity on a vertical occurs.

2.64 Mean Velocity (at a cross-section) — Velocity at a given cross-section of a stream, obtained by dividing the discharge by the cross-sectional area of the stream at that section.

2.65 Mean Velocity (of a reach) — Velocity calculated by dividing the discharge by the average cross-sectional area of the stream along the reach.

2.66 One-Point Method — Observations of velocity are made in each vertical at one point (for example at 0.6 of the depth) below the surface.

2.67 Two-Point Method — Observations of velocity are made in each vertical at two points (for example 0.2 and 0.8 of the depth) below the surface.

NOTE — Generally, the mean velocity value is the mathematical average of the observations.

2.68 Three-Point Method — Observations of velocity are made in each vertical at three points (for example 0.2, 0.6 and 0.8 of the depth) below the surface.

NOTE — Generally, the mean velocity value is the mathematical average of the observations.

2.69 Velocity of Approach, Approach Velocity — Mean velocity at a cross-section at a specified distance upstream of a measuring device.

2.70 Velocity Head — Head due to velocity, equal to the kinetic energy per unit weight of flowing fluid.

NOTES

1 The velocity head is the kinetic energy per unit weight of the flowing fluid.

2 It is expressed as the square of the velocity divided by twice the acceleration due to gravity.

2.71 Gauged Head — Level of the water surface or stage related to the invert of the flume or weir crest level or an arbitrary datum such as below the thalweg.

2.72 Piezometric Head — Sum of the free surface elevation and the pressure head.

NOTE — At any cross-section, it is the total head above the datum minus the velocity head at that cross-section.

2.73 Total Head, Energy Head, H — Sum of the elevation of the free surface above the horizontal datum of a section plus the velocity head based on the mean velocity at that section.

NOTE — The total head, H, is given by the following equation:

$$H = h + \alpha \frac{\overline{v}^2}{2g}$$

where

h = head of the liquid level,

$\overline{v}$ = mean velocity of the liquid,

a = Coriolis coefficient; and

g = acceleration due to gravity.

The Coriolis coefficient ($a \geq 1$), also known as energy coefficient or energy correction factor, takes into account the

non-uniform velocity distribution. In many cases, *a* is assumed to equal unity.

2.74 Total Head Line, Energy Head Line — Plot of the total head in the direction of flow.

2.75 Total Head Level — Sum of the elevation of the free surface and the velocity head based on the mean velocity at the section.

2.76 Energy Gradient — Difference in total head per unit horizontal distance, measured in the direction of flow.

2.77 Energy Loss, Head Loss (between cross-sections)**,** V — Difference in total head between two cross-sections in the direction of flow.

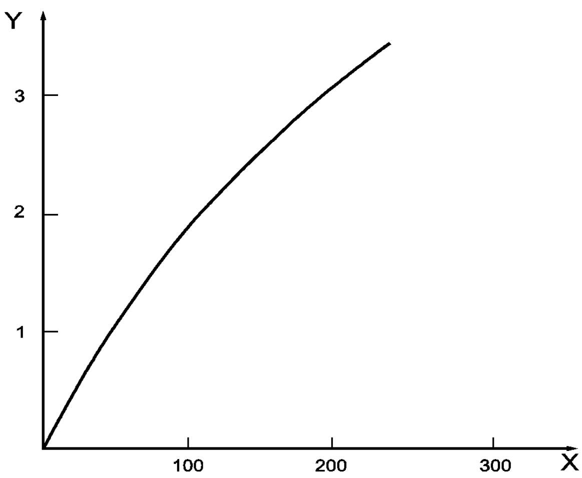
2.78 Specific Energy — Sum of the elevation of the free surface above the bed and the velocity head based on the mean velocity at that section.

2.79 Stage, Gauge Height, Liquid Level — Elevation of the free surface of a stream, canal, river, lake or reservoir relative to a specified datum.

2.80 Gauge Height of Zero Flow — Highest point on the thalweg downstream from the gauge in a natural or artificial channel.

2.81 Gauge Height of Zero Flow Line — Line on a shift diagram where the sum of the stage plus the shift adjustment is equal to the gauge height at zero flow for the rating.

2.82 Stage-Discharge Relation, Rating Curve — Curve, equation or table that expresses the relation between the stage and the discharge in an open channel at a given cross-section, for a given condition of steady, rising or falling stage (*see* Fig. 1).



Key

X — discharge, m^3/s

Y — stage, m

FIG. 1 STAGE-DISCHARGE RELATION

2.83 Stage Hydrograph — Graphical representation of changes in stage with respect to time.

2.84 Discharge Hydrograph — Graphical representation of changes in discharge with respect to time.

2.85 Shift Adjustment — Correction made to the recorded stage to compensate for vertical movement of the bed or for shifting of the control reach.

2.86 Cumulative Volume Curve, Mass Discharge Curve — Curve in which the cumulative volume of flow or flow mass is plotted against time.

2.87 Gauging Station — Site selected on a stream, river or open channel at which systematic measurements of water level or discharge, or both, are made.

2.88 Single-Gauge Station — Gauging station at which stage records from a single gauge are adequate to establish a stage-discharge relation.

2.89 Twin-Gauge Station, Slope Station — Gauging station at which two water-level gauges define a reach for measurement of water-surface slope as an essential parameter for establishing a stage-discharge relation.

2.90 Control — Physical properties of a cross-section or a reach of an open channel, either natural or artificial, that govern the relation between stage and discharge at a location in the open channel.

2.91 Rating — Relation between discharge and other variables, or the taking of observations and making of calculations needed to establish the relation.

2.92 Calibration (of a station) — Establishment of a discharge relation with the measured variable(s).

NOTE — Also referred to as the rating of a station.

2.93 Unit-Fall Rating — Relation between stage and discharge when the fall is equal to one.

2.94 Discontinuous Rating — Rating that exhibits a change in shape resulting from a change from lower- to upper-flow regime in all or part of the control reach.

NOTE — The change in shape is usually abrupt.

2.95 Shift Diagram — Curve or set of curves expressing the relation between stage and shift adjustment for a given rating.

2.96 Afflux — Rise in liquid level immediately upstream of, and due to, an obstruction.

2.97 Backwater — Afflux upstream of a given location on an open channel resulting from impedance offered to flow.

NOTE — Backwater may be caused by a momentary storage of water in a channel.

2.98 Backwater Curve — Profile of water surface,

concave upwards, along an open channel, from the raised surface at an obstruction or confluence to the point upstream at which the flow is at normal depth.

NOTE — The term is also used to denote all liquid surface profiles that are non-uniform with respect to distance upstream or downstream. However, this usage is deprecated.

2.99 Drawdown Curve — Profile of the liquid surface when its surface slope exceeds the bed slope.

NOTE — From the point at which the bed slope increases, or drops abruptly, to the point at which normal depth occurs, the profile along an open channel is convex upwards in an upstream direction and concave upwards in a downstream direction.

2.100 Depth, D — Linear dimension measured in the vertical direction from the water surface to the bed.

2.101 Normal Depth — Depth from the water surface to the bottom grade line of a channel for uniform flow.

NOTE — Normal depth is a function of the geometry, slope and roughness of the channel, and of the rate of discharge.

2.102 Length, l — Linear dimension measured in the direction of the stream flow.

2.103 Width, Breadth — Linear dimension measured perpendicular to the direction of the stream.

2.104 Frazil Ice — Fine spicules, plates or discoids of ice suspended in water that are generally formed by the supercooling of turbulent water.

NOTE — Frazil ice may float or accumulate under ice cover or adhere to the stream bed as anchor ice.

2.105 Anchor Ice — Submerged ice found attached to the bed, irrespective of the nature of its formation.

2.106 Rime Ice — White mass of tiny ice crystals or granular ice tufts formed on exposed objects due to atmospheric moisture.

2.107 Surface Ice, Ice Cover, Ice Sheet — Layer of ice formed on the surface of a lake or river.

2.108 Slush Ice — Mass of loosely packed anchor ice that is released from the bottom, or frazil ice that floats or accumulates under surface ice.

2.109 Peak Stage — Maximum instantaneous stage during a given period.

2.110 Friction, Drag — Boundary shear resistance that opposes the flow of a liquid.

2.111 Conveyance, *K (ISO)* — Carrying capacity of a channel.

NOTE — The term "conveyance factor" is used also in the form, $K = QS^{-1/2}$

where

K = conveyance factor,

Q = total discharge; and

S = energy gradient.

2.112 Hydraulic Jump — Sudden transition from supercritical flow to subcritical flow.

NOTE — Immediately upstream of the hydraulic jump, the velocity and the depth are respectively greater and less than their critical values; beyond the jump, the velocity and the depth are respectively less and greater than their critical values.

2.113 Hydraulic Mean Depth, Mean Depth, r_a — Area of the cross-section of water flowing in an open channel divided by the width of the open channel at the water surface.

2.114 Hydraulic Radius, r_h — Cross-sectional area of water flowing in an open channel divided by the length of the wetted perimeter at that cross-section.

2.115 Stage Gauge — Device installed for measuring the level of the surface of the liquid relative to a gauge datum.

2.116 Gauge Datum — Elevation of the zero of the gauge to which the level of the liquid surface is referred.

NOTE — The gauge datum is related to a benchmark.

2.117 Benchmark — Permanent mark, the elevation of which should be related, where practicable, to a national datum.

2.118 Gauge Well, Stilling Well — Chamber open to the atmosphere and connected with the stream in such a way as to permit the measurement of the stage in relatively still water.

2.119 Stilling Tube — Tube connected with the stream in such a way as to permit the measurement of the stage in relatively still liquid.

2.120 Float Well — Stilling well in which a float device is used.

2.121 Rugosity Coefficient, Roughness Coefficient — Coefficient that characterizes the roughness of the channel cross-section and which is taken into account when computing the resistance to flow or the energy gradient.

NOTE — The common types are the Manning's *n*, Chezy *C* or an element roughness height, *k*.

2.122 Froude Number, F_r — Mean velocity divided by the square root of the product of the hydraulic mean depth and the acceleration due to gravity:

$$F_r = \frac{\bar{v}}{\left(g^{D_m}\right)^{1/2}}$$

where

$\bar{v}$ = mean velocity of the liquid,

g = acceleration due to gravity, and

D_m = hydraulic mean depth of the cross-section.

NOTE — The Froude number is dimensionless.

2.123 Reynolds Number, *Re* — Ratio of the forces of inertia to forces of viscosity.

NOTES

1 For open channels, $Re = \frac{\bar{v} r_h}{\eta}$

where

$\bar{v}$ = mean velocity of the liquid,

r_h = hydraulic radius of the cross-section, and

h = kinematic viscosity of the liquid.

2 The Reynolds number is dimensionless.

2.124 Weber Number, *We* — Ratio of the forces of inertia to surface tension forces.

NOTES

1 For open channels, $We = \frac{\rho \bar{v}^2 \bar{D}}{\sigma}$

where

r = Density of the liquid,

$\bar{v}$ = Mean velocity of the liquid,

$\bar{D}$ = Hydraulic mean depth of the cross-section, and

s = Surface tension of the liquid.

2 The Weber number is dimensionless.

2.125 Telemetry — Data or information acquisition system in which the measurement facility is sufficiently remote from the location of data presentation that a system of data transmission is necessary.

2.126 Remote Sensing (hydrometry) — Acquisition of data or information on some property of an object or phenomenon by a sensor which is significantly remote from the object or phenomenon.

NOTES

1 Common usage of this term usually implies that the sensor is mounted in an aircraft or in a space vehicle.

2 It is recommended that the term not be used when the sensor merely is not in contact with the object or phenomenon.

2.127 Remote Telemetry Station — All the facilities necessary to accept or acquire measured data and to transmit that data from a hydrometric station without human intervention.

2.128 Remote Telemetry Unit — Set of equipment which acquires the input of signals from sensors and status indicators, and performs all the processes required to present a data message to a communication link.

2.129 Encoding — Process of converting data to a specific code.

2.130 Parity Check — Addition of an extra bit so that the total number of bits in a sample is either always even or always odd.

2.131 Code — Set of rules which specifies the format in which data may be represented.

2.132 System — Set of elements organized to perform a set of designated functions in order to achieve the desired results.

2.133 Data, Raw Data — Output resulting directly from the measurement of variables.

2.134 Energy — Quantity characterizing the ability of a system to do work.

2.135 Power, *P* — Time rate required for transferring energy, transforming energy, or doing work.

2.136 Work — Transfer of energy expressed as the product of a force and the distance through which its point of application moves in the direction of the force.

2.137 Hardware — Tangible equipment associated with a system.

2.138 Software — Intangible element of a system which, when applied to the hardware, enables the system to perform in the desired manner.

2.139 Firmware — Element of hardware whose associated software is integrated during manufacture.

NOTE — In operation, the hardware and the software act together as a fixed entity.

2.140 Real Time — Pertaining to the processing of data by a computer in connection with another process outside the computer according to time requirements imposed by the outside process.

2.141 Free Surface Flow — Flow within a closed or open conduit, under gravity and having a free surface.

NOTE — Where the flow exceeds the free surface capacity of the conduit, the flow will become surcharged with the consequent disappearance of the free surface. Instances of surcharging of short duration do not normally affect the overall concept of free surface flow in closed conduits.

2.142 Hydrometry — Science and practice of the measurement of water including the methods, techniques and instrumentation used.

NOTE — The adjective is "hydrometric".

2.143 Hydrological Cycle — Constant movement of water in all states of its form, above, on and below the earth's surface.

2.144 Hydrogeology — Study of subsurface water in its geological context.

2.145 Hydraulic Gradient — Change in static head per unit distance in a given direction.

2.146 Static Head, Static Water Level — Height, relative to an arbitrary reference level, of a column of water that can be supported by the static pressure at a given point.

2.147 Creek (river) — Small river, often a tributary to a larger river.

2.148 Creek (sea coast) **—** Recessed inlet on a sea coast or estuary.

2.149 Hydrograph — Relation in graphical, educational or tabular form between time and flow variables such as depth, discharge, stage and velocity.

NOTE — Typically, stage and discharge hydrographs are used for open channel flows.

2.150 Gradually Varied Unsteady Flow — Generally non-uniform flow in which there are no abrupt changes in depth along the longitudinal axis of a channel and in which depth, together with discharge and velocity, changes with time.

2.151 Live Storage — Reservoir storage which can be drawn off for users downstream.

2.152 Total Storage — Reservoir storage between the lowest bed level and the top water level.

2.153 Flood Storage — Volume of water temporarily held above the top water level of a reservoir during a flood event.

NOTE — Flood storage is not retained in the reservoir but is discharged through an overflow until the normal top water level is reached.

2.154 Boundary Condition — Condition to be satisfied by a dependent variable of a differential equation along the boundary of a model domain.

2.155 Courant Condition — Condition for the numerical stability of the explicit formulation of a numerical scheme which requires that the ratio, *C*r, of the propagation speed of a physical disturbance to that of a numerical signal should not exceed unity, that is *C*r < 1.

NOTE — The condition is a requirement for an explicit finite-difference formulation applied to a hyperbolic partial differential equation.

2.156 Explicit Finite — Difference Numerical Scheme — Scheme which converts either the characteristic equation or the governing equation into an equation from which any unknown may be evaluated directly (explicitly) without an iterative computation.

NOTES

1 Dependent variables on the advanced time level are determined one point at a time from known values and conditions at the present or previous time levels.

2 The stability of an explicit scheme is conditional upon an error being a function of the time and distance finite-difference step sizes which may result in an error growing as the solution progresses.

3 When the Courant condition is met, resulting in limitations in the maximum time and distance steps which can be used, an explicit scheme is generally stable, but there can be instances of instability.

4 If the converted equation is linear and algebraic, an iterative computation is not needed.

2.157 Implicit Finite — Difference Numerical Scheme — Scheme which converts either the characteristic equation or the governing equation into a non-linear algebraic equation from which an unknown may be evaluated iteratively.

NOTES

1 All of the unknowns within the model domain are determined simultaneously.

2 Generally, an implicit scheme is stable.

3 Although complex algorithms are required, generally an implicit scheme is computationally sufficient.

2.158 Initial Condition — Description of the discharge, depth of flow or other dynamic condition at the beginning of a simulation period for unsteady flow models.

NOTE — For subsequent times, the state of the system is described by the governing equations and the boundary conditions.

2.159 Method of Characteristics — Mathematical approach for solving boundary values by transforming the original partial differential equations representing the physical system into corresponding characteristic equations.

NOTE — Characteristic equations are ordinary differential equations and are generally more amenable to numerical solution than are the partial differential equations.

2.160 Momentum Coefficient, Boussinesq Coefficient — Quantification of the deviation of the velocity at any point in a cross-section from a uniform velocity distribution in the same cross-section.

NOTE — Values of the coefficient correspond to the following:

a) Unity indicates that a uniform velocity distribution is present in the cross-section,

b) 1.01 to 1.12 indicates a fairly straight prismatic channel, and

c) Greater than 1.12 indicates a large or a deep channel.

2.161 Standing Wave, Stationary Wave — Curved symmetrically shaped wave on the water surface and on the channel bed, that are virtually stationary.

NOTE — When standing waves form, the water surface and the bed surfaces are roughly parallel and in phase.

2.162 Isotropic — Having the same properties in all directions.

2.163 Photomultiplier — Electronic device for amplifying and converting light pulses into measurable electrical signals.

2.164 Water Course (irrigation) — Channel which feeds water from a branch canal or a distributary to a delineated block of land.

2.165 Tributary — Surface or underground stream which contributes its water, continuously or intermittently, to another large or larger stream.

2.166 Brook — Small shallow stream, usually

continuous in its discharge, which flows in somewhat turbulent manner.

NOTE — Its channels are usually irregular in shape and have numerous boulders, ledges or small drops which cause the turbulent flow.

2.167 Longitudinal Section — Section representing an object as cut through its centre (or as specified) lengthwise and vertically.

2.168 Delta — Quantity of irrigation water, expressed in depth units over the irrigated area, stated with reference to the place at which it is measured or assessed.

Example

Delta at farm, delta at outlet, head of watercourse or lateral head, delta at distributary head, delta at head of main canal.

2.169 Delta Reach of River — Reach of a river when it approaches the sea, with very gradual bed slope and surface slope, and, at low velocity, deposits its sediment and divides out into channels on either side of the deposits, resulting in the formation of deltas.

2.170 Water Level — Altitude reached by the surface of flowing or still water.

2.171 Saturation Line, Line of Saturation, Percolation Line, Hydraulic Grade Line — Line across the banks on either side of a canal, in filling or partly in filling and partly in cutting, up to which the banks get saturated after the canal has been running for some time (*see* Fig. 2).

2.172 Annual Flood — Highest momentary peak discharge, recorded at the respective point of observation, which is equalled or exceeded once every year.

2.173 Annual Storage, Within-the-Year Storage — Difference between the maximum and minimum volumes in storage over a year of reservoir operation.

2.174 Base Flow — Sustained flow of stream resulting from outflow of groundwater and from drainage of large lakes and swamps.

NOTE — Base flow includes water sustained in glaciers, snow and other sources, not a result of direct runoff.

2.175 River Capture — Process by which a river having more rapid power of erosion than another cuts into the headwaters of the latter and takes over certain of its tributaries.

2.176 Drainage Basin — Part of the land area enclosed by a topographic divide from which direct surface runoff from precipitation drains by gravity into a stream or other water body.

3 VELOCITY-AREA METHODS

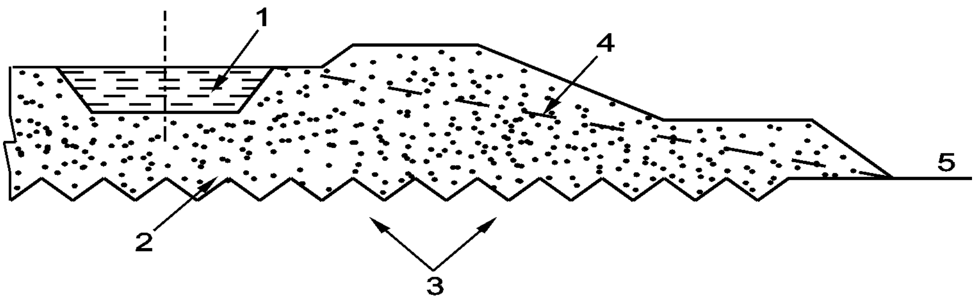
3.1 Velocity-Method — Method of determining discharge from the area of the cross-section, bounded by the wetted perimeter and the free surface, while integrating the component velocities in the cross-section.

3.2 Slope-Method — Indirect method of determining discharge in a reach which is based on the friction (energy) slope, the reach roughness, the wetted perimeters and the flow areas of the various wetted cross-sections in the reach.

3.3 Mean Direction of Flow — Direction in which the summation of the component velocity elements in a cross-section is a maximum when the components are taken along that direction.

3.4 Vertical — Vertical line on which velocity measurements or depth measurements are made.

3.5 Drift (measuring boat) **—** Distance that a measuring boat travels during the time taken to make a velocity observation.



Key

1 — canal
2 — earth filling
3 — scratched ground (for bonding)
4 — saturation line
5 — ground level

FIG. 2 CANAL IN FILLING

3.6 Drift (current meter) — Distance that a current meter assembly is carried downstream when used with a flexible suspension.

3.7 Drift Velocity — Velocity in the direction of the drift current.

3.8 Period of Pulsation — Average period of a cycle of pulsation during which the velocity in the cross-section fluctuates between limiting high and low values.

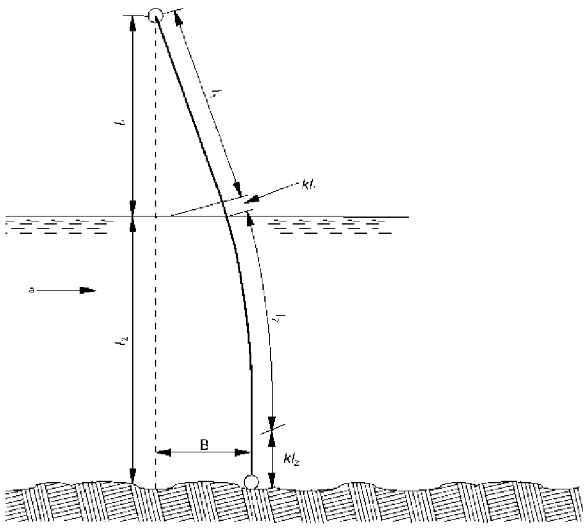
3.9 Vertical Velocity Curve — Curve showing the relation between depth and velocity along a vertical line in a specified section of a stream (*see* Fig. 3).

3.10 Velocity Vertical Gradient — Change in velocity per unit distance along the vertical velocity curve.

3.11 Vertical Velocity Coefficient — Coefficient applied to a single, velocity determination at any depth on a vertical to infer the mean velocity on that vertical.

3.12 Sounding — Operation of measuring the depth from the free surface to the bed.

3.13 Air Line Correction — Correction to the sounding line measurement applied to that part of the sounding line above the liquid surface (*see* Fig. 4).



Key

kl_1 — air line correction.

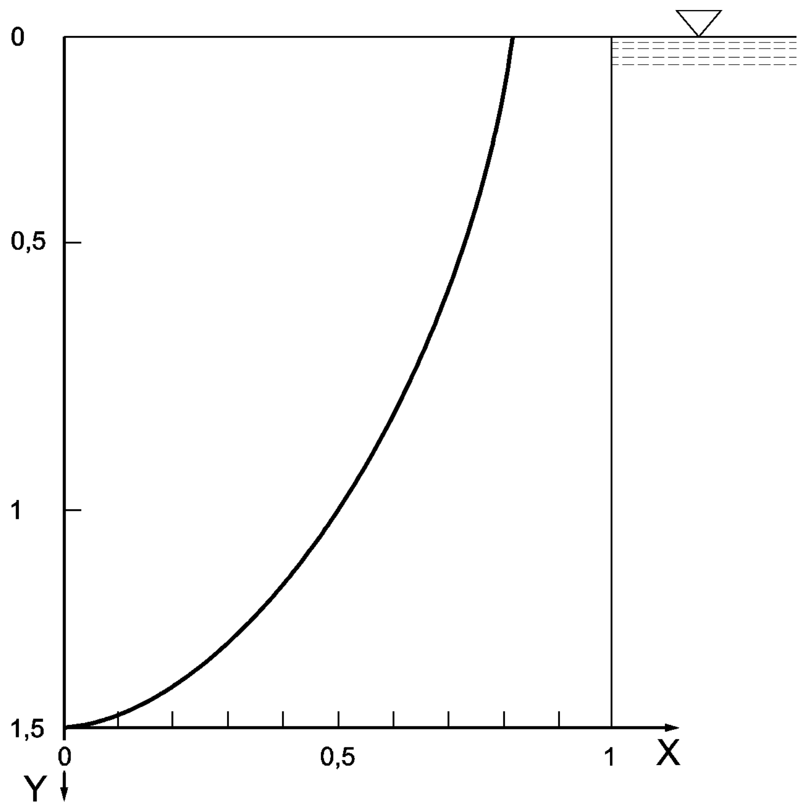
kl_2 — wet line correction.

B — drift.

a — direction of flow.

FIG. 4 SOUNDING LINE CORRECTIONS

3.14 Wet Line Correction — Correction to the



Key

X — velocity, m/s.

Y — depth below surface, m.

FIG. 3 VERTICAL VELOCITY CURVE

sounding line measurement applied to that part of the sounding line below the liquid surface (*see* Fig. 4).

3.15 Reference Gauge — Stage gauge normally linked to a specified datum.

3.16 Reference Current Meter — Current meter that is immersed at a fixed position in the cross-section during the discharge measurement.

NOTE — For slight changes in discharge during the gauging operation, it is assumed that the change in velocity indicated by the reference current meter is proportional to the change in discharge.

3.17 Standard Current Meter — Calibrated current meter used as a basis of comparison with other current meters.

3.18 Velocity Integration Method (velocity-area measurement) — Method of measuring the velocity along a vertical, involving the raising and lowering of a current meter at a constant rate through the entire depth of the vertical.

3.19 Point Velocity Method — Method of measuring the velocity along a vertical by placing a current meter at a number of designated points on the vertical.

NOTE — The velocity is usually measured at one, two, three, five or six points on the vertical.

3.20 Float Gauging — Measurement of velocity of a stream by means of a float or floats.

3.21 Moving Boat Method — Method of measuring discharge from a boat by traversing the stream along the measuring section while continuously measuring velocity, depth and distance travelled and angle of current velocity.

3.22 Channel Storage — Generally, volume of liquid contained in an open channel at a given instant or specifically, volume contained in a defined reach at a given instant, as a function of the mean depth of flow in the reach.

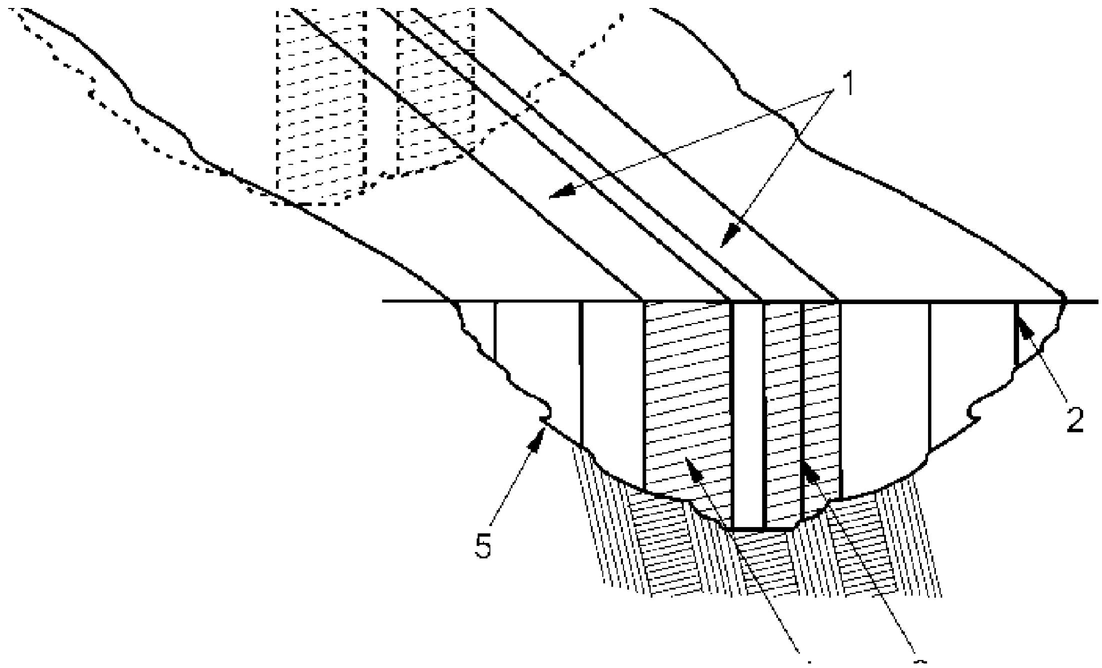
3.23 Mean Section Segment — Area bounded by two consecutive verticals in a cross-section, the bed of the open channel and the water surface (*see* Fig. 5).

3.24 Mid-Section Segment — Area at a vertical defined by the depth at that vertical multiplied by one-half of the distance between the preceding and succeeding verticals (*see* Fig. 5).

3.25 Stream Panel — That part of the surface of the stream enclosed between the corresponding traces of segments in adjacent cross-sections (*see* Fig. 5).

3.26 Storage Curve — Curve depicting the volume of stored water plotted against stage or time.

3.27 Cubature — Numerical technique for computing



Key

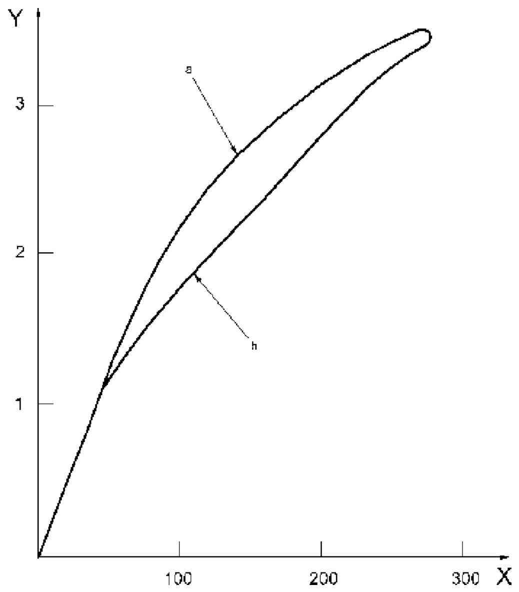
1 — stream panels.
2 — vertical.
3 — mid-section segment.
4 — mean section segment.
5 — bed profile.

FIG. 5 GEOMETRIC DEFINITIONS

discharge in a tidal channel at a cross-section from the rates of change in volume of water up to the tidal limit, with algebraic allowance for the fresh water discharges entering the channel.

NOTE — The maximum volume is usually that occurring at high water of spring tide.

3.28 Looped Stage-Discharge Curve, Hysteresis of the Stage-Discharge Relation — Effect on the stage-discharge relation at a gauging station where, for the same gauge height, the discharge on the rising stage is different from that on the falling stage (*see* Fig. 6).



Key

X — discharge, m^3/s.

Y — stage, m.

a — falling stage.

b — rising stage.

FIG. 6 LOOPED STAGE-DISCHARGE CURVE

3.29 Sensitivity of the Stage-Discharge Relation — Measure of the change in stage of a gauging station due to a change in discharge.

NOTE — When a small increase in discharge produces a relatively large increase in stage, the relation is said to be sensitive. When a large increase in discharge produces a relatively small increase in stage, the relation is said to be non-sensitive.

3.30 Stilling Well Lag — Difference at a given instant between the channel stage and the stilling well stage, during conditions of rising and falling stages in a channel.

3.31 Fall Stage-Discharge Relations, Slope-Stage-Discharge Relation — Family of curves that expresses the relationship between the free water surface slope, stage and discharge in a given reach of an open channel subject to variable backwater.

3.32 Normal Fall Stage-Discharge Relation, Normal Fall Method — Relationship between stage and discharge established graphically from a number of distinct sets of measurements of stage, discharge and fall, at a gauging station subject to variable slope, so as to define the condition of minimum backwater in terms of the upstream gauge.

3.33 Constant Fall Stage-Discharge Relation, Constant Fall Method — Relationship, established by graphical interpolation, between a number of distinct sets of measurements of stage, discharge and fall, recorded at a gauging station subject to variable slope, so as to define those pairs of stage and discharge measurements for which the measured fall has the same value.

3.34 Tide — Periodic rise and fall of water due principally to the gravitational attraction of the sun and the moon.

3.35 Ebb Tide — Occurrence of falling water surface of a tide.

3.36 Ebb Current — Current experienced during ebb tide.

3.37 Flood Tide — Occurrence of rising water surface of a tide.

3.38 Flood Current (tidal) — Current experienced during flood tide.

3.39 Spring Tide — Tide of large amplitude, occurring twice during the lunar month, when the resultant of the attractive forces of the sun and the moon acting upon the earth is at a maximum.

3.40 Neap Tide — Tide of small amplitude, occurring twice during a lunar month near the time of quadrature of the moon with the sun, that is when the resultant of the attractive forces acting upon the earth is at a minimum.

3.41 High Water (tidal) — State of tide when the water is highest for any given tidal cycle.

3.42 Low Water (tidal) — State of the tide when the water is lowest for any given tidal cycle.

3.43 Ebb Volume — Total discharge of an ebb tide.

3.44 Flood Volume (tidal) — Total discharge of a flood tide.

3.45 Tidal Amplitude — One-half of the difference in height between consecutive high water and low water, hence half the tide range.

3.46 Tidal Cycle — Period that includes a complete set of tide conditions or characteristics, such as a tidal day.

3.47 Tidal Day — Interval between two upper transits of the moon over a local meridian.

NOTE — Approximately 24.84 h.

3.48 Duration of Tide — Time taken for the completion of one tidal cycle.

NOTE — Usually, the duration is either 12.42 h for a semidiurnal tide or 24.84 h for a diurnal tide.

3.49 Tidal Prism — Volume of water that flows into a tidal channel on the flood tide.

3.50 Tidal Range — Difference in level between high water and low water of a tide.

NOTE — The range is specific to a particular tide if consecutive high and low waters are used; otherwise, the range can refer to extremes of high and low waters over any specified period of time.

3.51 Diurnal Inequality (waters) — Difference in heights and durations of the two successive high waters or two successive low waters of each day.

3.52 Diurnal Inequality (currents) — Difference in speed and direction of the two flood currents or the two ebb currents of each day.

3.53 Seiche — Oscillation of the surface of a liquid caused mainly by winds and variations in atmospheric pressure.

3.54 Density Current — Phenomenon of gravity flow of a liquid relative to another liquid or of relative flow within a liquid medium due to difference in density.

NOTE — *see* salt-water wedge (**3.55**).

3.55 Salt-Water Wedge — Wedge-like intrusion of a large mass of salt water flowing in from the sea under the fresh water in a tidal waterway.

3.56 Current Meter — Instrument for measuring water velocity.

3.57 Flood Flow — Flow corresponding to or exceeding natural bankfull stage.

3.58 Bankfull Stage — Stage at which an open watercourse just overflows its natural banks.

3.59 Divergence of Tidal Conditions — Angular deviation in degrees between the flow axis of the ebb current and of the flood current, at a point where the axes cross.

NOTES

1 In a straight ideal reach, there will generally be no deviation.

2 When conditions are not ideal, the ebb and the flood directions are not on the same axis and there will be an angular deviation.

3.60 Mixed Tide — Tide which has at least two markedly unequal successive high waters, or at least two markedly unequal successive low waters, or both.

3.61 Ebb Predominance — Situation where the ebb flow exceeds the flood flow, over a tidal cycle, at a point or on a vertical.

NOTE — Usually, the extent of the predominance is assessed using integration of velocity-time graphs.

3.62 Flood Predominance — Situation where the flood flow exceeds the ebb flow, over a tidal cycle, at a point or on the vertical.

NOTES

1 Usually, the extent of the predominance is assessed using integration of velocity-time graphs.

2 When an integration value is a net zero, there is no predominance.

3.63 Sand Point — Pipe with a well screen, underlying or adjacent to a stream, in which a gas-purge orifice is installed.

3.64 Fall Velocity, Settling Velocity, Terminal Velocity — Limiting velocity reached asymptotically by a particle falling under the action of gravity in still water.

3.65 Vertical Velocity Distribution — Variation in velocity in a stream or river between the surface and bed (*see* **2.9**).

3.66 Vertical-Velocity-Curve Method — Observations of velocities normally taken at several points of the depth (for example at 0.1-depth increments between 0.1 and 0.9 of the depth) below the surface.

4 FLOW MEASUREMENT STRUCTURES

4.1 Flow Measurement Structure — Hydraulic structure (for example weir, flume or gate) installed in an open channel where in most cases the discharge can be derived from the measured upstream water level.

4.2 Weir — Overflow structure that may be used for controlling upstream surface level or for measuring discharge or both (*see* Fig. 7).

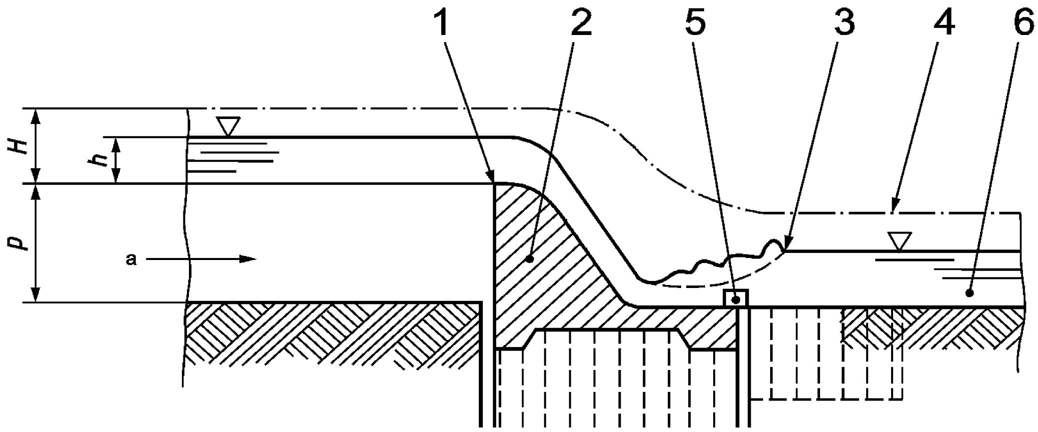
4.3 Height of Weir, Apex Height — Height from the upstream bed to the lowest point of the crest.

4.4 Head Over the Weir — Elevation of the water surface above the lowest point of the crest, measured at a point sufficiently upstream to be unaffected by the drawdown of the weir.

NOTE — The distance upstream of the point of measurement depends on the type of weir used.

4.5 Upstream Total Head — Elevation of the total head relative to the flume invert level or the weir crest level, measured upstream of the structure.

4.6 Downstream Total Head — Elevation of the total head relative to the flume invert level or the weir crest level, measured downstream of the structure.



Key

1 — weir crest.
2 — weir block.
3 — hydraulic jump.
4 — total head line.
5 — control block.
6 — stilling basin.
a — direction of flow.

FIG. 7 WEIR

4.7 Weir Abutment, Abutment, Wing Wall — Wall at the side of a channel, generally parallel to the longitudinal axis of the weir, against which the weir terminates.

4.8 Weir Block, Weir Body — Part of a weir lying between the abutments and over which the water flows.

4.9 Full Width Weir, Suppressed Weir — Weir whose crest fills the width of the channel in which it is placed, thus eliminating side contraction of the stream.

4.10 Divide Wall — Wall running in the direction of flow and separating the individual sections of a compound structure.

4.11 Glacis — Sloping downstream face of a weir block and continuation of the crest.

4.12 Weir Slope — Ratio of the horizontal to the vertical components of the upstream face, the downstream face or the cross-slope of a weir.

4.12.1 *Upstream Face Weir Slope* — Ratio of the horizontal to the vertical components of the upstream face of a weir.

4.12.2 *Downstream Face Weir Slope* — Ratio of the horizontal to the vertical components of the downstream face of a weir.

4.12.3 *Cross-Slope* — Ratio of the horizontal to the vertical components of the slope of a weir.

4.13 Approach Channel — Reach of the channel upstream of the gauging structure in which suitable flow conditions have to be established to ensure correct gauging.

4.14 Straightening Vane, Guide Vane — Device placed in the approach to improve flow conditions.

NOTE — A similar purpose is served by the use of baffles; *see also* **4.15**.

4.15 Baffle — Wall or block placed downstream of a structure to dissipate energy or to cause improved velocity distribution.

4.16 Control Block, Baffle Pier, Energy-Block — Block constructed in a channel or stilling basin to increase turbulence and thereby dissipate the energy of water flowing at high velocity (*see* Fig. 7) for the application of a control block to a weir construction.

4.17 Stilling Basin — Basin constructed downstream of a structure to dissipate the energy of fast-flowing water and to protect the bed and banks from erosion (*see* Fig. 7).

4.18 Separation Pocket (at a corner or at a point of large curvature) — Region of recalculating flow in a structure caused by separation of the main flow from the structure.

NOTE — This phenomenon can occur at broad-crested weirs which do not have rounded upstream or downstream corners or which do not have a crest of sufficient length in the direction of flow.

4.19 Separation Pocket (triangular-profile weir) — Near-cylindrical volume of slowly moving water immediately downstream of the crest of the structure.

4.20 Throat — That part of a flume at which critical flow occurs, usually where the wetted cross-sectional area is at a minimum.

NOTE — The throat may be rectangular, trapezoidal, U-shaped or of another specially designed shape.

4.21 Modular Flow, Free Flow — Flow over or through a structure when the upstream level is independent of the downstream level for a given discharge.

4.22 Discharge Coefficient — Coefficient in the discharge equation depending on the type and shape of the measuring structure and the head over the weir.

4.23 Modular Limit — Submergence ratio for flow over a weir at which the upstream level just begins to be affected by the downstream level for a given discharge.

4.24 Drowned Flow, Non-modular Flow, Submerged Flow — Flow, over or through a structure, when it is affected by changes in the level downstream.

4.25 Submergence Ratio — Ratio of the downstream total head to the upstream total head in a structure.

4.26 Critical Flow — Flow conditions for which the total energy head above the invert reaches a minimum at a given discharge and for given channel dimensions.

NOTES

1 This is the specific definition of critical flow when used in reference to the field of flow measurement structures.

2 The water depth for these flow conditions is called critical depth and occurs during the transition from subcritical to supercritical flow.

3 Critical flow in overflow structures and undershot gates occurs at the critical section, also called the control section. Critical flow in a measuring structure is a condition for modular flow.

4.27 Double Gauging — Measurement of two simultaneous but independent heads to facilitate measurement in the drowned flow range.

NOTE — The usual head measurement locations lie between $3H_{Max}$ upstream of the weir and $3H_{Max}$ downstream of the weir, where $3H_{Max}$ is the maximum total head over the weir crest.

4.28 Broad-Weir — Weir with a horizontal longitudinal crest which has a length equal to or greater than the maximum operating head (*see* Fig. 8).

NOTE — The streamlines above the crest are approximately straight and parallel, at least over a short distance.

4.28.1 *Rectangular Broad-Weir* — Broad-crested weir of which the crest is a horizontal rectangular plane surface and of which the upstream face forms a sharp right-angled corner at its intersection with the plane of the crest (*see* Fig. 8).

4.28.2 *Round-Broad-Weir* — Broad-crested weir of which the crest is a horizontal rectangular plane surface and of which the upstream corner is rounded to avoided flow separation (*see* Fig. 8).

4.28.3 *Trapezoidal Broad-Weir* — Broad-crested weir of which the crest is a horizontal plane surface and of which the upstream face and the downstream face are sloping (*see* Fig. 8).

4.28.4 *V-Broad-Weir* — Broad-crested weir with a triangular cross-sectional profile, rounded off at the upstream corner (*see* Fig. 8).

4.29 Nappe — Jet formed by the flow over a weir (*see* Fig. 9).

4.29.1 *Clinging Nappe* — Nappe that maintains contact with the downstream face of a weir.

4.29.2 *Unconfined Nappe* — Nappe where the guide walls of the structure end at the crest (or at the edge), thus permitting free lateral expansion of the flow.

4.29.3 *Fully Ventilated Nappe, Fully Aerated Nappe* — Nappe springing clear of the downstream face of the weir with atmospheric pressure on the underside of the nappe.

4.29.4 *Fully Developed Contraction* (nappe) — Contraction that occurs when further increases in the depth or width of the approach channel no longer affects the nappe.

4.30 Thin-Plate Weir, Sharp-Weir — Weir constructed of a vertical thin plate from which the nappe springs clear of the crest, provided that the nappe is ventilated (*see* Fig. 9).

NOTE — The streamlines above the crest are strongly curved.

4.31 Thin-Notch Weir — Weir whose crest is a notch cut in a thin plate (*see* Fig. 10).

4.32 Short-Weir — Weir with a horizontal longitudinal crest that is shorter in length than half the maximum operating head or with a longitudinal crest which is concave, convex or uneven.

NOTE — The streamlines above the crest are curved.

4.33 Triangular-Weir — Two-dimensional weir with a triangular longitudinal profile (*see* Fig. 11).

NOTE **—** Usually, the upstream slope is 1:2 and the downstream slope is 1:5.

4.34 Streamlined Triangular-Weir — Two-dimensional weir with a triangular longitudinal profile in which the sharp edge between the two sloping faces is replaced by a circular arc connecting the two faces tangentially.

4.35 Flat-Weir — Triangular profile weir with a crest that is shallow and V-shaped when viewed in the direction of flow (*see* Fig. 12).

NOTE — Usually, the cross-slope of the V shape is 1:10, 1:20 or 1:40.

4.36 Compound Structure — Series of weirs and/or flumes that may be of different crest levels, which are disposed across the width of an open channel and separated by divide walls (*see* Fig. 13).

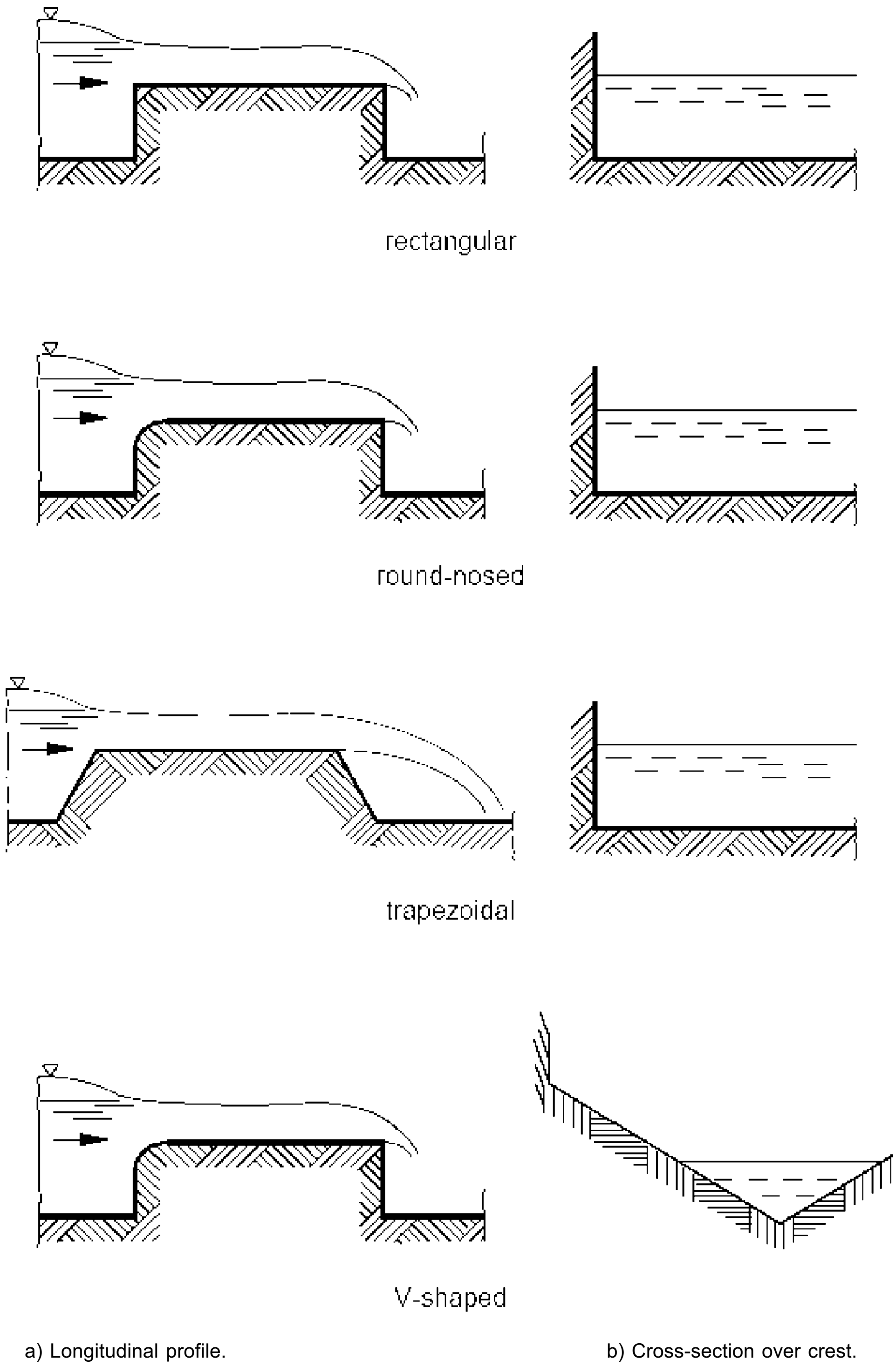
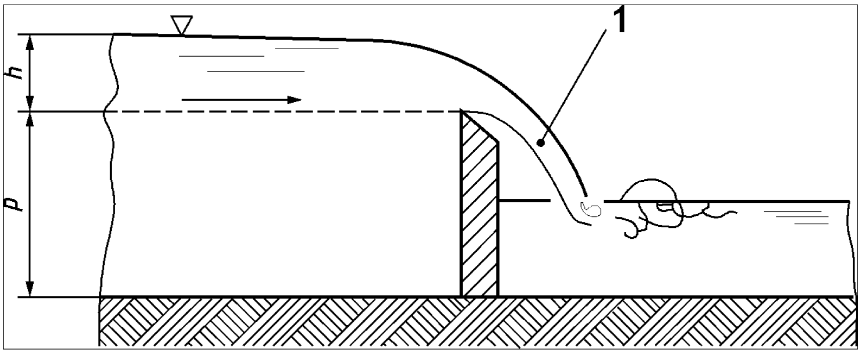
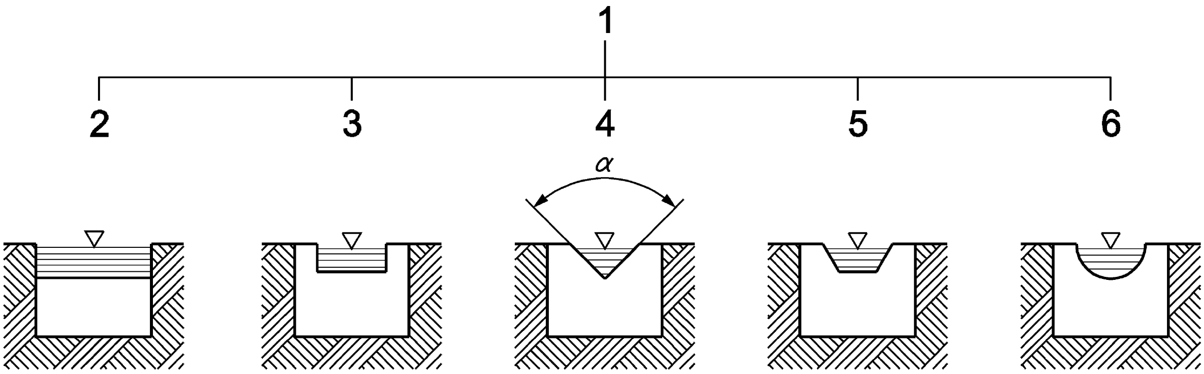


FIG. 8 BROAD-CRESTED WEIRS



Key
1 Nappe

FIG. 9 THIN-PLATE WEIR



Key

1 — thin-plate notch weir.
2 — full width.
3 — rectangular.
4 — triangular (V-notch).
5 — trapezoidal.
6 — circular.

FIG. 10 THIN-PLATE WEIRS

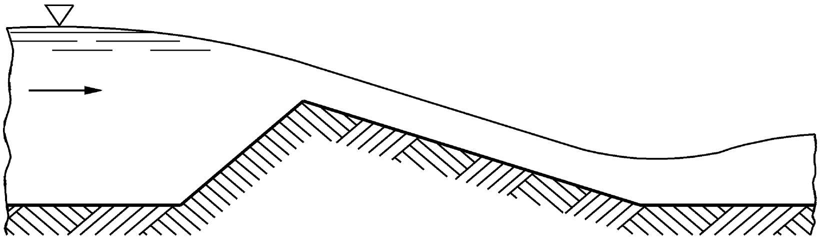


FIG. 11 TRIANGULAR-PROFILE WEIR (LONGITUDINAL PROFILE)

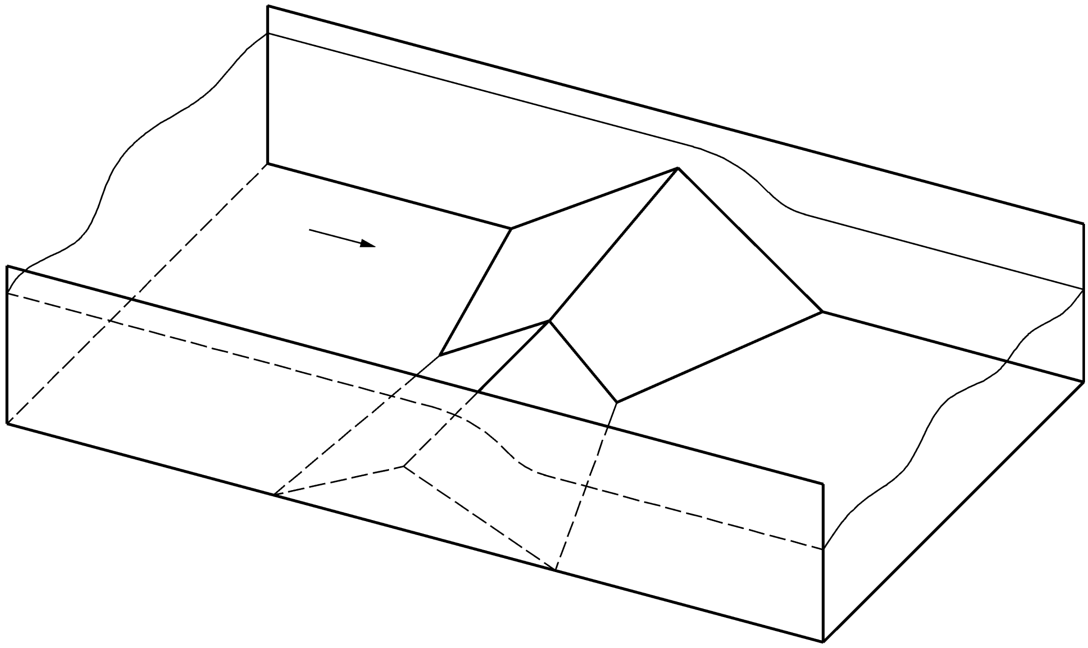
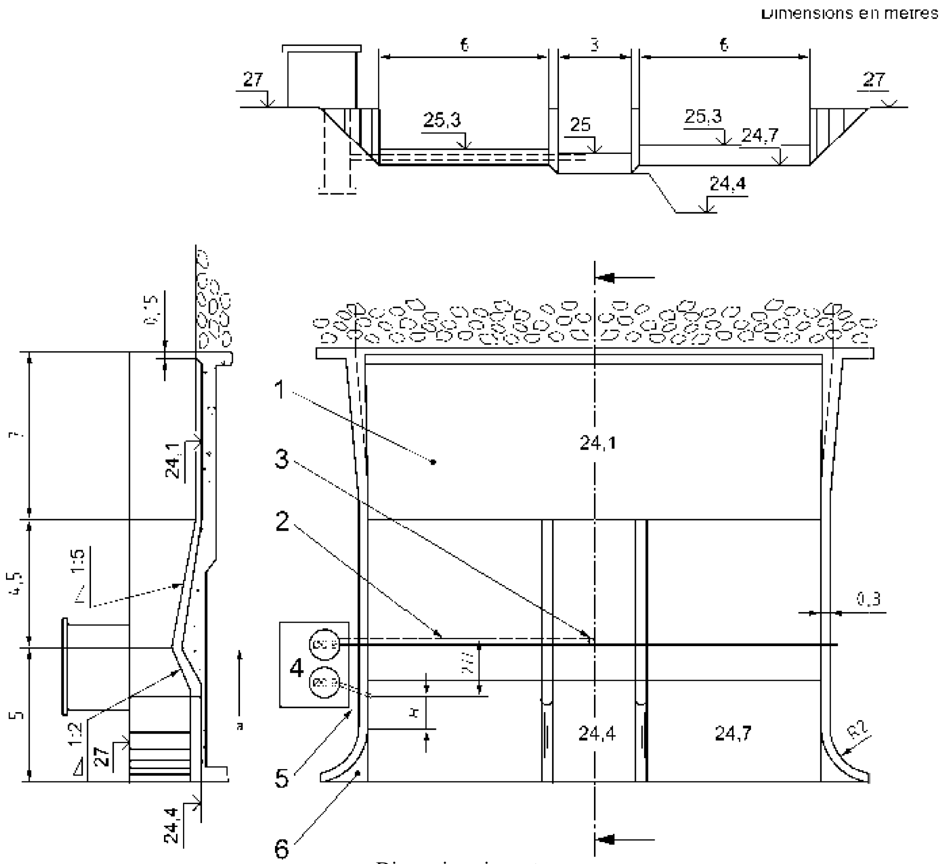


FIG. 12 FLAT-V WEIR



Dimensions in metres.

Key

1 — stilling basin.

2 — crest-tapping pipe: Ø 0.1.

3 — connecting pipe to crest-tapping box (0.3 × 0.6 0.15): Ø 0.01.

H — head over weir.

4 — recorder housing.

5 — intake: Ø 0.1.

6 — transition formed.

a — Direction of flow.

FIG. 13 EXAMPLE OF COMPOUND STRUCTURE DESIGN

4.37 End-Method — Approximate method to establish the discharge in a horizontal or gently sloping channel, when the bed is discontinued abruptly, by measuring the head exactly at the commencement of the free overfall.

4.38 Flume — Streamlined constriction in an open channel usually consisting of an entrance section, a throat section and a downstream expansion, that can be used for measurement of flow.

4.38.1 *Critical-Flume, Standing-Flume* — Measuring flume of dimensions that produce critical flow in the throat and in which the measurement of only the upstream water level permits the calculation of discharge.

4.38.2 *Long-Flume* — Measuring flume having a throat length equal to or greater than the maximum operating head (*see* Fig. 14).

NOTE — The streamlines in the throat section are approximately straight and parallel, at least over a short distance.

4.38.3 *Short-Flume* — Measuring flume having a substantially shorter throat length as compared with long-throated flumes.

NOTE — The streamlines in the throat section are curved.

4.38.4 *Throatless Flume* — Measuring flume which does not have a parallel-walled throat and which does not generate parallel flow at the critical section.

4.38.5 *Parshall Flume* — Measuring flume having a converging entrance section with a level floor, a short-throat section with a floor inclined downwards at a gradient of 3:8, a diverging exit section with a floor inclined upwards at a gradient of 1:6, and having a specified cross-section depending upon the range of discharge flowing in the channel (*see* Fig. 15 B).

4.38.6 *Saniiri Flume* — Measuring flume with a converging entrance section having a level floor with a fall at its downstream end and vertical walls to join it to the downstream channel (*see* Fig. 15 A).

4.39 Vertical Underflow Gate — Vertical gate, situated in a channel of rectangular cross-section with a flat bed, for regulating the water level upstream of the gate or the discharge through the gate opening.

NOTES

1 The gate is movable in vertical slots and it can be raised or lowered by hand or mechanically.

2 The underflow is two-dimensional except at vertically narrow gate openings.

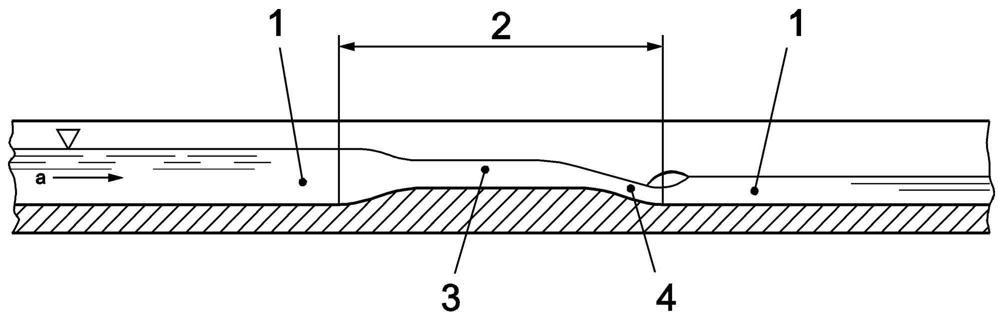
5 DILUTION METHODS

5.1 Tracer — Ion, compound or radionuclide introduced into a flow system to follow the behaviour of some component of that system.

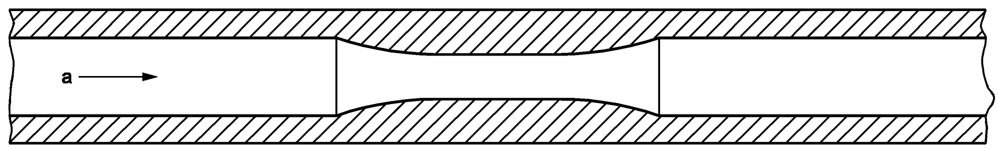
NOTE — It is necessary that the tracer, which can be observed, behaves in exactly the same fashion as the component to be followed whose behaviour cannot easily be observed.

5.2 Dilution Gauging — Gauging method in which the discharge is deduced from the determination of the ratio of the concentration of the injected tracer to that of the tracer at the sampling cross-section.

5.3 Constant-Injection Method — Method of



14A Longitudinal profile



14B Plan view

Key

1 — subcritical flow.

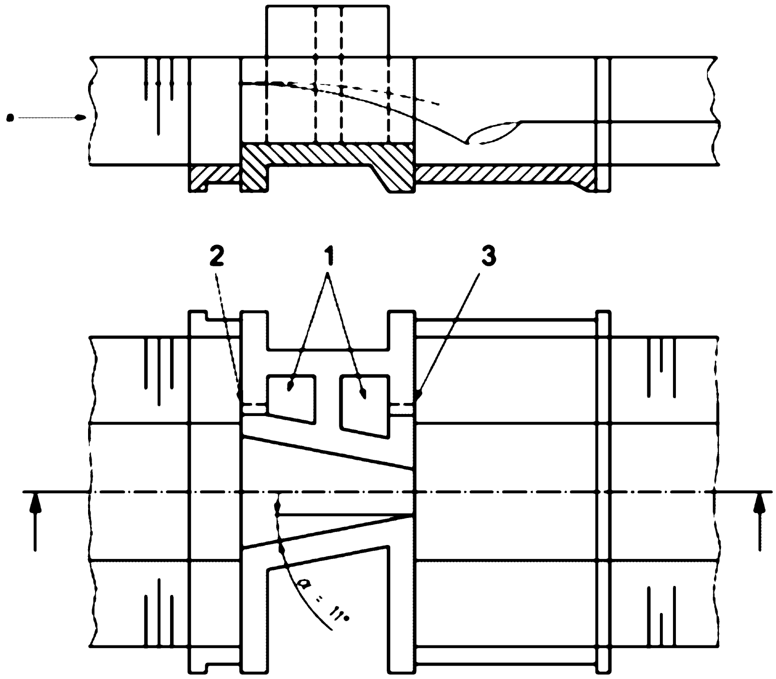
2 — throat.

3 — critical flow.

4 — supercritical flow

a — direction of flow.

FIG. 14 LONG-THROATED FLUME



15 A Saniiri flume

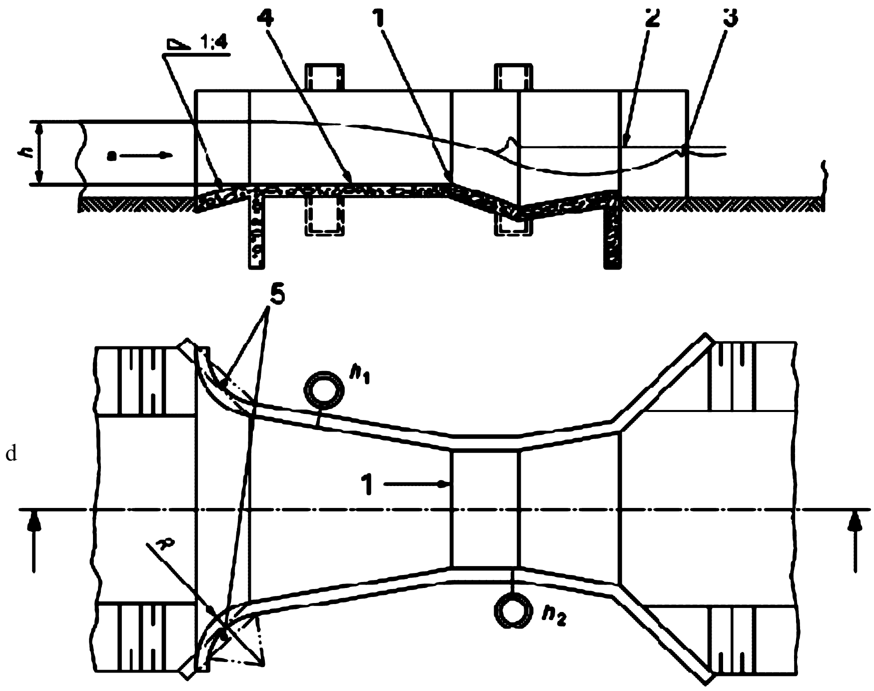
Key

1 — stilling wells.

2 — h_1 intake.

3 — h_2 intake

a — direction of flow



15 B Parshall flume

Key

1 — crest.

2 — partially submerged flow.

3 — free flow.

4 — level floor.

5 — alternative 45° wing wall.

a — direction of flow.

FIG. 15 MEASURING FLUMES WITH CONVERGING ENTRANCE SECTION

measuring the discharge in which a tracer of known concentration is injected at a constant and known rate at one cross-section and its dilution is measured at another section located sufficiently downstream that complete mixing has taken place.

5.4 Integration Method, Dilution Gauging (dilution methods) — Method of measuring the discharge in which a known quantity of tracer is injected over a short time at one cross-section and its dilution is measured at another cross-section located sufficiently downstream that complete mixing has taken place, and allowing sufficient time for all the tracer to pass that cross-section so that the mean concentration of tracer during the sampling time can be determined.

5.5 Multiple Injection — Simultaneous injection of tracer at several points in the injection cross-section with the aim of improving transverse mixing in a given downstream measuring reach.

5.6 Background Concentration — Concentration of the tracer substance or a substance that reacts like the tracer in the detection scheme used in the liquid in the channel, and that is not attributable to the injection of the tracer for the gauging, that is present upstream or before the injection.

5.7 Constant Level Tank — Equipment for the injection of a concentrated solution at constant rate.

NOTE — Using the overflow weir, a constant head is maintained above a selected nozzle or orifice.

5.8 Mariotte Vessel — Equipment for the injection of a concentrated solution at constant rate.

NOTE — Constant-rate injection is achieved by means of an airtight vessel provided with an orifice plate or nozzle at its bottom portion. The liquid flows through the constriction and air enters the vessel through a tube maintaining atmospheric pressure at the lower end of the tube set at a determined height above the constriction. The head on the constriction and consequently the injection rate remain constant, regardless of the level of liquid in the vessel.

5.9 Floating Siphon — Equipment for the injection of a concentrated solution at constant rate.

NOTE — The solution is taken from a vessel by means of a siphon that is fixed on a float. The lower end of the siphon is fitted with an orifice plate or nozzle. The head on the constriction and consequently the injection rate remain constant, regardless of the level of liquid in the vessel.

5.10 Mixing Length (constant-rate injection method) — Minimum length of the reach between the injection cross-section and cross-sections where the tracer concentration is homogeneous in the section.

5.11 Mixing Length (integration method) — Minimum length of the reach between the injection cross-section and the cross-section where transverse mixing is such that the integral of the tracer concentration as a function of time is constant throughout the section.

5.12 Degree of Mixing — Extent to which mixing has been achieved in a cross-section downstream of the point of injection of the tracer.

NOTE — The degree of mixing immediately downstream of an injection is nearly zero. Complete (100 percent) mixing does not occur until further downstream.

5.13 Adsorption — Fixation of an ion (for example a tracer) from a solution onto the surface of a solid (for example sediment in suspension).

5.14 Dilution Ratio, Dilution Factor (constant-rate injection method) — Ratio between the concentration of the injected tracer solution and the concentration of added tracer detected at the sampling cross-section when steady conditions have been reached.

5.15 Dilution Ratio, Dilution Factor (integration method), N — Ratio between the concentration of the injected tracer solution and the mean of the concentration of added tracer detected at the sampling cross-section.

5.16 Sampling Cross-section, Sampling Station — Cross-section of an open channel, downstream of the injection cross-section, at which samples are taken or in which concentration is directly measured.

5.17 Standard Solution — Reference solution containing a selected concentration of dissolved substance.

5.18 Dispersion of a Tracer — Process by which differential velocities, turbulent motions and the rate of diffusion of a liquid cause the spreading of a cloud of dissolved or suspended substances throughout the liquid.

NOTE — In a stream, dispersion generally takes place vertically in the water columns, transversely across the stream and longitudinally in the direction of flow.

5.19 Dispersion Coefficient of a Tracer — Coefficient used to describe the capacity of a moving liquid to dissipate an initially localized substance or property throughout the liquid.

NOTE — In open channel flow, dispersion takes place vertically, transversely and longitudinally. Each component of the dispersion has its own dispersion coefficient.

5.20 Time of Travel of a Tracer — Time for the movement of liquid, or of dissolved materials, between cross-sections in an open channel.

NOTES

1 Time of travel may refer to leading edge, the peak concentration, the mass centroid or the trailing edge of a dissolved material in a stream.

2 When the term is used for the time of travel of any part of the tracer other than the centroid, it should be qualified.

5.21 Tracer Recovery Ratio — Ratio of the tracer mass recovered in a stream to the tracer mass injected, as determined by sampling.

5.22 Unit Tracer Concentration — Concentration of a tracer in a stream for one unit of injected conservative tracer in one unit of discharge.

6 INSTRUMENTS AND EQUIPMENT

6.1 Vertical Gauge, Staff Gauge — Graduated vertical scale, fixed to a staff or to a structure against which the liquid level may be read.

6.2 Inclined Gauge, Ramp Gauge — Gauge on a slope generally graduated directly to indicate vertical heights.

6.3 Float Gauge — Gauge consisting essentially of a float that rides on the liquid surface and rises or falls with it, its movement being transmitted to a recording or indicating device.

6.4 Point Gauge — Gauge whose essential element is a pointed rod that is lowered until it touches the surface (*see* Fig. 16).

NOTE — The instant when the point touches the water surface is often indicated by an electrical device.

6.5 Hook Gauge — Gauge whose essential element is a pointed hook which, after immersion, is raised until it touches the surface (*see* Fig. 17).

6.6 Crest Stage Gauge — Gauge, usually vertical, used to indicate peak stage.

6.7 Wire Weight Gauge — Graduated gauge connected to a weighted wire or chain, which is lowered to make contact with the surface of the liquid.

NOTE — Contact with the liquid is determined visually.

6.8 Servo System — System that detects an imbalance between the actual and desired states of a controllable quantity and then applies a restoring force which reduces the imbalance to an acceptable value.

NOTES

1 The typical location of a servo system is the output shaft of an electromechanical water level sensing instrument.

2 A typical restoring force arrangement is to have the meter contact switches in the zero position to check that the output shaft corresponds to the correct water level.

6.9 Servo Manometer, Servo Beam Balance — Type of liquid head sensor that incorporates a servo system to convert a detected liquid pressure into a recording or an indication of the liquid level.

6.10 Elastic Pressure Bulb — Device, operating on a closed gas system, sometimes used to transmit liquid pressure to a sensor.

NOTE — It normally comprises a short cast hollow cylinder with an open end, sealed with a slack highly flexible diaphragm, connected to the sensor by means of suitable tubing.

6.11 Gas Purge Technique, Bubbler Technique — Method of transmitting liquid pressure in which a small discharge of non-corrosive gas or compressed air is allowed to bleed through a tube to an immersed fixed orifice.

NOTE — The pressure measured by a pressure sensor is directly proportional to the liquid head.

6.12 Backlash, Instrumental Hysteresis — Difference between the movement of the input mechanism and the associated movement of the stylus, occurring as a result of the mechanical linkage.

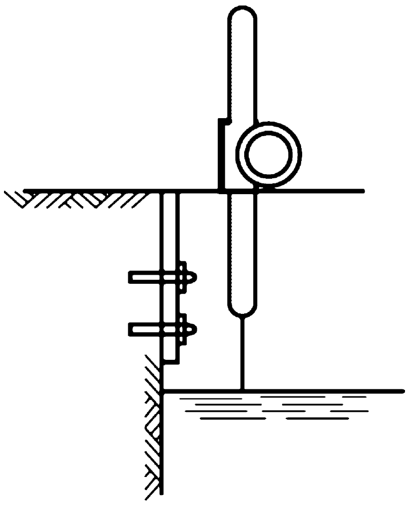


FIG. 16 POINT GAUGE

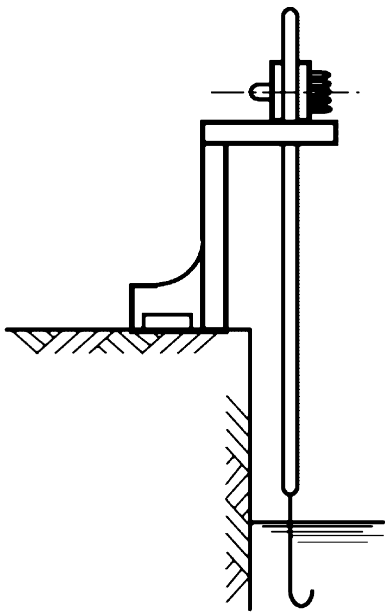


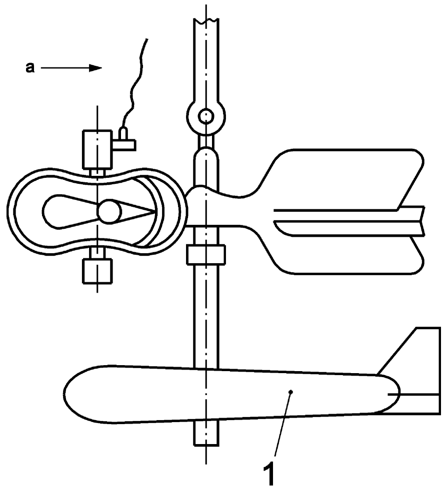
FIG. 17 HOOK GAUGE

6.13 Liquid Level Recorder, Stage Recorder — Device that records automatically, either continuously or at regular time intervals, the liquid level as detected by a sensor.

6.14 Sensor — Device that responds to a physical or chemical stimulus.

6.15 Rotating Element Current Meter — Device provided with a rotor, the rotational velocity of which corresponds to the local velocity of the surrounding liquid.

6.16 Cup-Type Current Meter — Current meter whose rotor is composed of a wheel fitted with cups turning on a vertical axis and perpendicular or nearly perpendicular to the flow (*see* Fig. 18).

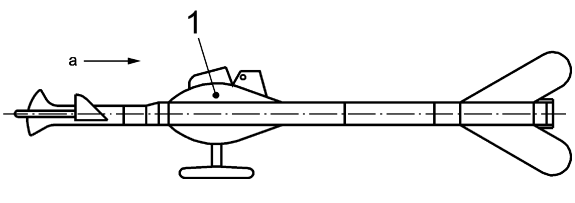


Key
1— sounding weight.
a — direction of flow.

FIG. 18 CUP-TYPE CURRENT METER

6.17 Propeller-Current Meter — Current meter whose rotor is a propeller rotating around an axis approximately parallel to the flow (*see* Fig. 19).

NOTE — "Propeller" is also known as "impeller".



Key
1 — sounding weight.
a — direction of flow.

FIG. 19 PROPELLER TYPE CURRENT METER

6.18 Component Propeller-Current Meter — Propeller-type current meter whose rotor is designed to compensate an angular flow component.

NOTE — "Propeller" is also known as "impeller".

6.19 Propeller Pitch — Degree of inclination or slope of the blade, or the distance that a given propeller would advance in one revolution.

NOTE — "Propeller" is also known as "impeller".

6.20 Rotor Pitch — Degree of inclination or slope of the blade, or the distance that a given rotor would advance in one revolution.

6.21 Spin Test — Test in which the rotor of a current meter is spun, either with the fingers or by blowing into the cup or into the propeller, to check that it rotates freely and uniformly.

6.22 Minimum Speed, Velocity of Response — Velocity of the liquid, relative to the rotor of a current meter, at which the rotor attains continuous and uniform angular motion.

NOTE — Velocity of the liquid, relative to the rotor of a current meter which is immersed in the liquid, at which continuous and angular motion of the rotor is initiated.

6.23 Rating Tank, Calibration Tank — Tank containing still liquid through which the current meter is moved at a constant velocity in order to calibrate the meter.

6.24 Epper Effect — Phenomenon in which the disturbance produced by a current meter and its suspension, moving forward, in a rating (calibration) tank interferes with and reduces the rate of rotation of a mechanical meter's rotor.

6.25 Cableway System, Cableway — Cable and carriage, often incorporating a winch, used for placing measuring or sampling instruments at any desired point in the cross-section.

6.26 Main Cable, Track — Anchored cable in a cableway system along which the instrument or personnel carriage travels (*see* Fig. 20 and Fig. 21).

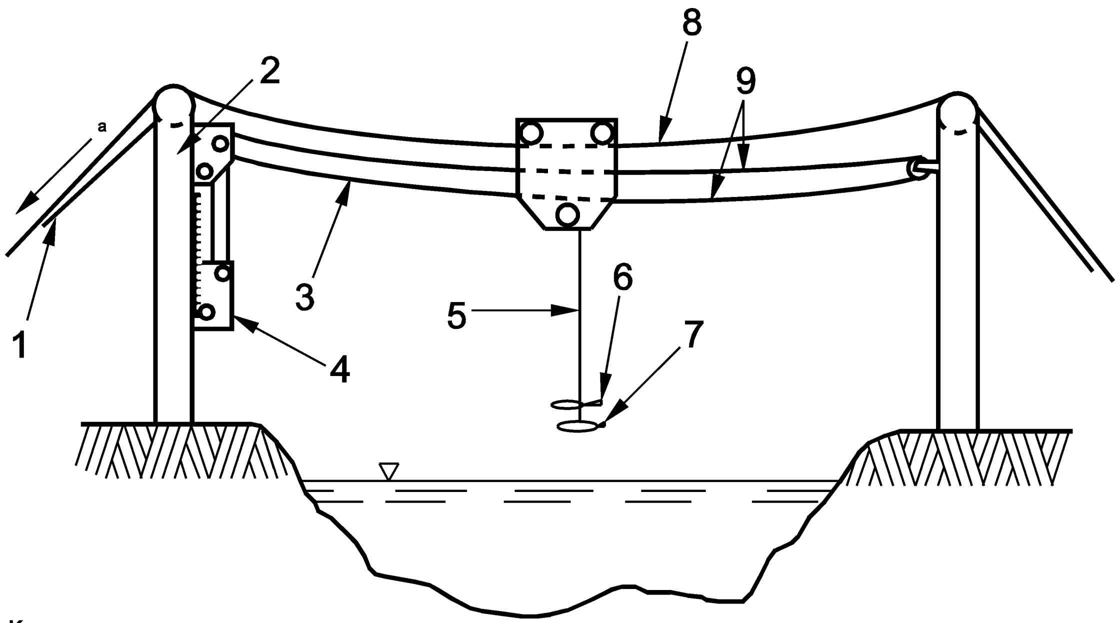
6.27 Suspension Equipment — Cables and cable winches or rigid rods to which hydrometric instruments may be attached for suspension in a channel.

6.28 Anchorage — Cableway fixture to which the track (main cable) or stay line is attached (*see* Fig. 20 and Fig. 21).

6.29 Stay Line — Cable, placed between the towers (pier posts) and anchorages, that is used with a manned cableway system for ensuring the stability of the towers (pier posts) (*see* Fig. 20 and Fig. 21).

NOTE — Stay lines are sometimes also used with an unmanned cableway system.

6.30 Suspension Cable — Wire, from which the current meter is suspended, possibly incorporating an electrically insulated core and controlled by the winch (*see* Fig. 20 and Fig. 21).



Key

1 — stay lines
2 — tower (pier post)
3 — suspension cable
4 — double—drum winch
5 — suspension cable
6 — current meter.
7 — sounding weight
8 — main cable
9 — tow cable
a — to anchorages

FIG. 20 CABLEWAY SYSTEM: TYPICAL UNMANNED INSTRUMENT CARRIAGE

6.31 Tow Cable, Traversing Cable — Moving cable controlled by the winch, by which an instrument carriage is positioned from the bank (*see* Fig. 20).

6.32 Hand-Suspension — Suspension of the current meter by a hand-held suspension cable or rod, used for gauging from bridges or similar structures.

6.33 Gauging Reel, Winch — Drum-type hand-or machine-operated winch around whose drum is wound a suspension cable.

6.34 Double-Winch — Winch with two drums, one of which controls the suspension cable while the other controls the movement of an unmanned cableway carriage (*see* Fig. 20).

NOTE — The cableway carriage control drum may be a spooling drum or a friction-drive pulley driving an endless loop. The operator is able to drive both drums simultaneously in traversing mode, or to lock the traversing drum in sounding mode so as to operate the suspension cable drum only. The same operations may be carried out using two single drum winches, each allocated to one function. Measuring counters are fitted to record horizontal and vertical cable movements.

6.35 Bridge Winch Board — Hardwood plank, reinforced with brass or steel, to which a hand-operated suspension cable winch is bolted, constructed to slide along bridge handrails to travel between gauging observation points.

6.36 Sounding Weight, Sinker — Weight of streamlined shape attached to a sounding line or to the suspension of a current meter when observing depths or velocities in streams (*see* Fig. 20 and Fig. 21).

6.37 Sounding Rod, Sounding Line — Graduated rigid rod or a chain or cable, usually with a weight attached to its lower end, used for determining depth.

6.38 Wading Rod — Light, hand-held, graduated rigid rod for sounding depth and positioning the current meter for measuring the velocity in shallow streams suitable for wading (*see* Fig. 22).

NOTE — A wading rod may also be used from boats or ice cover at shallow depths.

6.39 Pendant Wire, Tag — Wire or cord marking the measuring section and carrying pendants or markers to indicate the position of the observation points.

NOTE — The wire or cord is not used for suspending apparatus.

6.40 Float — Any natural or artificial body that is supported by buoyancy (Archimedian) forces (*see* Fig. 23).

6.41 Surface Float — Float with its greatest drag near the surface, used to determine surface velocities (*see* Fig. 23 a).

6.42 Subsurface Float — Float with its greatest drag below the surface for measuring subsurface velocities (*see* Fig. 23 b).

6.43 Double Float — Body of slightly negative buoyancy that moves with the stream at a known depth and whose position is indicated by a small surface float from which it is suspended (*see* Fig. 23 c).

6.44 Velocity Rod, Rod Float — Float, in the form of a rod, weighted at its base so that it travels in a current in an almost vertical position, used for determining stream velocities (*see* Fig. 23 d).

NOTE — The immersed portion may be adjustable.

6.45 Echo Sounder — Instrument using the reflection of an acoustic signal from the bed to determine the depth.

6.46 Transducer — Device that responds to a phenomenon and produces a signal which is a function of one or more characteristics of the phenomenon.

6.47 Tracking Window (of an echo sounder) — Opening of limited size which follows and automatically centres itself at the depth indicated by the last received echo.

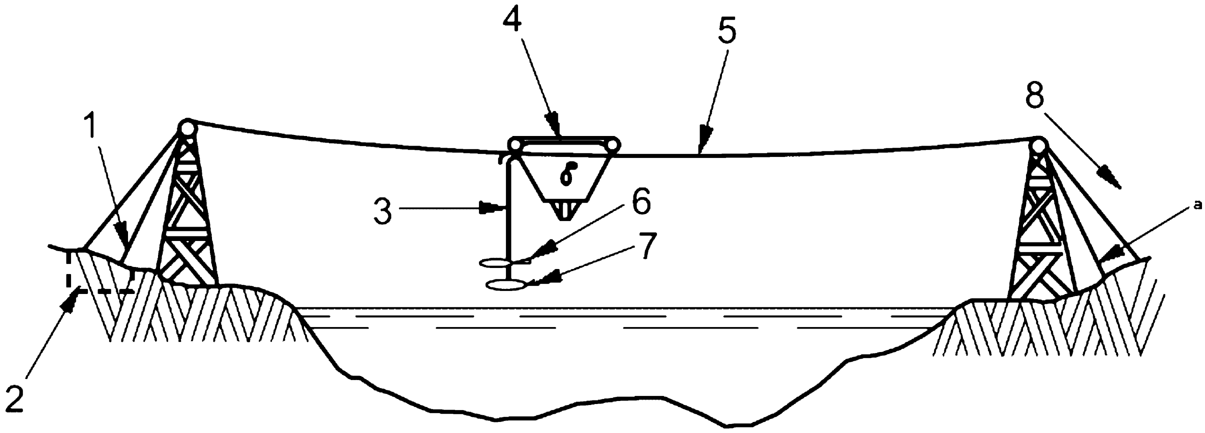
NOTES

1 If the next echo falls within the window, the signal is accepted as correct; if it does not, the signal is rejected.

2 The purpose of a tracking window is to screen out erroneous readings caused by fish, debris or other sonar-reflecting materials.

6.48 Pulse — Controlled transient increase or decrease in transmitted energy.

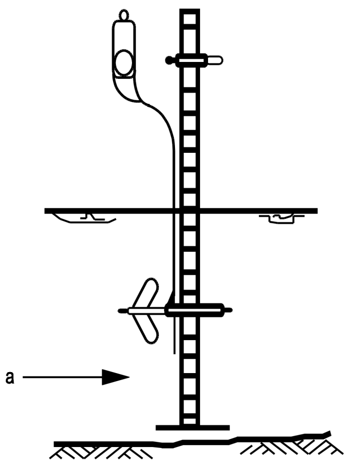
6.49 Bit — Binary digit (1 or 0) used to represent a number in binary notation.



Key

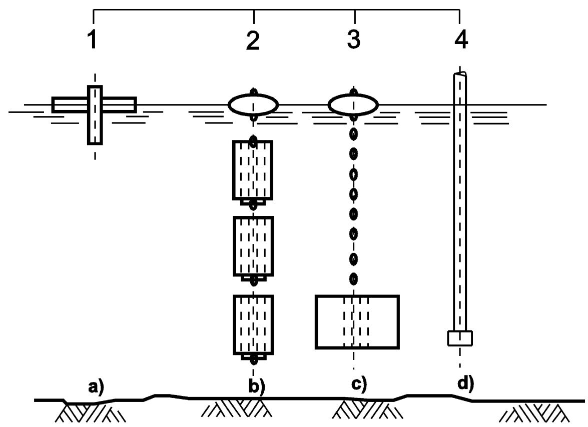
1 — stay lines
2 — anchorage
3 — suspension cable
4 — personnel carriage
5 — main cable
6 — current meter
7 — sounding weight
8 — stay line
a — to anchorages

FIG. 21 CABLEWAY SYSTEM: TYPICAL MANNED INSTRUMENT CARRIAGE



a — direction of flow.

FIG. 22 WADING ROD



Key

1 — surface float.
2 — subsurface float.
3 — double float.
4 — velocity rod.

FIG. 23 TYPES OF FLOATS

6.50 Byte — Group of adjacent binary digits operated on by a computer as a unit.

6.51 Baud, Bd — Unit measure of data flow on a communication path.

NOTE — Baud is a special name for the second to the power minus one for this quantity.

6.52 Electromagnetic Current Meter — Current meter which creates a magnetic field perpendicular to the flow direction, thus enabling the velocity to be deduced from the induced electromotive force produced by the motion of a conducting liquid in the magnetic field.

6.53 Ultrasonic (Acoustic) Velocity Meter — System that analyses the transmission of ultrasonic pulses in water to estimate velocity.

NOTE — There are several different techniques that are used to analyse the transmitted sound pulses, which include travel time, frequency and echo (acoustic) correlation.

6.54 Electromagnetic Gauging Station — Gauging station at which the integrated velocity is determined by inducing a magnetic field in the channel and measuring the induced electromotive force produced by the motion of the conducting liquid in the magnetic field.

6.55 Default Mode — Condition adopted automatically by a system unless it is directed otherwise, or condition to which it reverts when either it is unable to sustain the directed condition or the direction given is unclear.

6.56 Influencing Factor, Environmental Factor — Quantifiable effect of environmental elements, external to the measuring equipment, which may influence equipment performance.

6.57 Performance Measure — Degree to which the intended functions of the equipment are accomplished.

6.58 Range of Values — Span of values of a quantity used to measure an influencing factor.

6.59 Conditions of Storage and Transport — Conditions specified by the manufacturer, under which equipment may be stored and transported in an inoperative state and may be subjected to influences outside those experienced in operation.

NOTE — Under these conditions, the equipment may be specially packed or protected in whatever way considered appropriate by the manufacturer in order that it does not suffer damage or degradation of performance when subsequently operated within the range of operating conditions fore*see*n.

6.60 Operating Conditions — Conditions within which the equipment is expected to measure the determinant in accordance with the appropriate criteria of performance.

NOTE — The range of operating conditions will be defined by the user.

6.61 Abnormal Conditions of Equipment Use — Those conditions occurring only exceptionally, which lie outside the range applicable to equipment operation, and against which the equipment is provided with no special protection.

NOTE — The equipment is expected to resume required performance levels as soon as the influencing factors return to those lying within the range applicable to the operation mode. The limits of these conditions should be specified by the manufacturer.

6.62 Hazardous Area — Area in which there exist hazardous conditions potentially capable of endangering safety.

NOTE — Such conditions may be attributable to physical location or to a situation where a potentially explosive atmosphere may exist from time to time (for example in sewers).

6.63 Overall Performance Level — Statement of the expected performance of the equipment, relative to the true values of the measured hydrological variable.

6.64 Timing Performance — Statement of the expected performance of any timing element of the equipment which is employed to control the sampling rate or frequency of the equipment.

6.65 Permanent Flowmeter — Flowmeter installed for a long period of time (in excess of about 12 months) and used to determine flow continuously or at discrete time intervals.

NOTES

1 Any high costs incurred in the installation of these flowmeters may be tolerated as they are spread over a period of time.

2 The measurements provided may be used as the basis for an archive system to examine present trends, to forecast future trends and to determine daily operational requirements.

6.66 Temporary Flowmeter — Flowmeter installed for a specific period of time (no more than about 12 months) and used to determine flow continuously or at discrete time intervals.

NOTE — The installation of the flowmeter needs to be simple with minimal or no associated civil engineering costs.

6.67 Portable Flowmeter — Flowmeter, not used as part of a fixed installation, used to obtain instantaneous measurements of flow or the velocity and depth components thereof.

6.68 Hydrometric Equipment — Equipment used for the hydrometric monitoring of hydrological parameters.

6.69 Recording Device — Device that records automatically, either continuously or at regular time intervals, the parameters sensed by any associated sensors.

6.70 Recording Equipment — Equipment comprising one or more sensors and a recording device.

NOTES

1 Equipment producing a record demonstrating changes of value of a hydrological parameter with time may require the incorporation of a timing device.

2 If the record comprises observations of the changes in values of a sensed hydrological variable linked to changes in one or more other physical parameters, the recording equipment should monitor adequately such linkages.

6.71 Non-Equipment — Equipment comprising one or more sensors but no recording device.

6.72 Instrument Carriage — Device having one or more track wheels which run on the main cable, a pulley to support the instrument suspension cable and a point of attachment for the tow cable.

6.73 Load-Brake — Component of a manual gauging reel which prevents the reel handle from being driven by the load when the handle is released by the operator.

6.74 Payout Rate — Rate at which a traversing cable or a suspension cable is paid out by a gauging reel.

6.75 Torque Limiter — Device to limit the transmission of torque by causing the driving element to slip at a pre-determined rate.

6.76 Tower, Pier Post — Principal support structure for a cableway.

6.77 Minimum Winding Diameter — Minimum diameter of a drum or a pulley around which a cable may be wound or bent without causing damage to the cable.

6.78 Winding Handle — Handle of a manual gauging reel by which a motive force is applied.

6.79 Cableway Support — Structure that supports the main cable span across the stream.

NOTE — This structure may also provide mountings for the winch and pulleys (sheaves) carrying the tow and suspension cables.

6.80 Personnel Carriage — Work platform or cabin suspended from track wheels running on the main cable from which gauging observations are made.

6.81 Track Wheel — Sheave (grooved wheel) that rides on the main cable to support the carriage.

6.82 Ping — Series of acoustic pulses, of a given frequency, transmitted by an acoustic Doppler current profiler.

6.83 Ensemble — Collection of pings.

NOTE — Because the measurement from a single ping has relatively high uncertainty, the measurements from more than one ping are averaged to represent a single measurement.

6.84 Transect — Single pass across a river, lake or estuary.

NOTES

1 A transect may be described as a collection of ensembles.

2 One transect may constitute a single measurement of discharge.

6.85 Data Collection Platform — Instrument that gathers measurements from various sensors and then transmits them to receiving stations.

6.86 Data Logger — Device that can read various types of electrical signals and log the data in internal memory for later transmission by telemetry or downloaded to a laptop or memory card.

6.87 Acoustic Doppler Current Profiler — Instrument that uses the principle of Doppler shift to compute water velocity and discharge.

NOTE — These instruments are usually mounted on a vessel that transmits across a river channel, generally perpendicular to flow, to compute total discharge of the channel.

6.87.1 *Side-Looker/Horizontal ADCP, H-ADCP* — Device that uses the principle of Doppler shift to compute water velocity.

NOTES

1 These devices are usually fixed at the side of the channel and sample velocity in what is effectively a horizontal wedge across the watercourse.

2 It is not necessary to sample velocity across the full width of the channel.

6.88 Doppler Shift — In acoustic Doppler instruments, difference or shift in frequency of emitted sound waves as they are reflected back from moving particles in the water.

NOTE Only radial velocity with respect to stationary and moving particles/objects: measured either towards or away from the stationary measuring equipment.

6.89 Acoustic Doppler Velocity Meter — Class of instruments that uses the principle of Doppler shift to compute water velocity.

NOTE — These instruments are usually deployed at a fixed point in a cross-section and commonly used to develop an index velocity for the computation of an average velocity for that cross-section.

6.90 Blanking Distance — Distance travelled by the signal when the vibration of the transducer during transmission prevents the transducer from receiving echoes or return signals.

6.91 Bottom Tracking — Method where the velocity of the bottom is measured together with the water velocity, which allows the system to correct for the movement of the vessel.

6.92 Differential Global Positioning System — Enhancement to Global Positioning System that uses a network of fixed ground-based reference stations to

broadcast the difference between the positions indicated by the satellite systems and the known fixed positions.

6.93 Side-Interference — Reflections of the side-lobe energy from the river bed overwhelm the echoes of the main beam from particles near the bottom of the water column.

6.94 Radar Velocity Meter — Instrument that transmits an electromagnetic beam directed at the fluid surface at an oblique angle, thus collecting scattered radiation and its frequency compared with the frequency of transmission.

6.95 Optical Velocity Meter — Laser Doppler, particle image velocimetry and laser particle velocimetry devices located above the water that can be used to track the movement of disturbances and particles at, or close to, the water surface.

6.96 Echo (Cross) Correlation Velocity Meter — Device that uses the transmitting and receiving of consecutive ultrasound pulses to track the movement of flowing particles, both in time and space.

NOTE — The velocity of the moving particles is estimated and assumed to be the same as the velocity of the water.

7 SEDIMENT TRANSPORT

7.1 Fluvial Sediment — Solid particles derived from rocks, biological materials, or chemical precipitants, that are transported by, suspended in, or deposited by flowing water.

7.2 Fluvial Sediment Transport — Movement of solids transported in any way by a flowing liquid.

NOTE — This is usually expressed as the mass or volume of sediment passing a cross-section per unit time.

7.3 Total Load (origin) — Sum of the bed material load and the wash load (in suspension).

7.4 Total Load (transport) — Sum of the bed load and the suspended load.

7.5 Bed Material — Material of the same particle size as that which is found in appreciable quantities in that part of the bed affected by sediment transport.

7.6 Bed Material Load — That part of the total sediment transport that consists of bed material and whose rate of movement is governed by the transporting capacity of the channel.

7.7 Suspended Load — That part of the total bed material load that continues to remain in suspension by turbulence in the flowing water.

NOTES

1 It moves with practically the same velocity as the flowing water.

2 Suspended load is generally expressed in mass or volume per unit of time.

7.8 Bed Load — That part of the total load (transport) in almost continuous contact with the bed, carried forward by rolling, sliding or hopping.

7.9 Wash Load — That part of the total load that remains in suspension and is composed of particles washed from the catchment and whose size is normally smaller than those found in the channel bed.

NOTES

1 It is in near permanent suspension and, therefore, is transported through the stream without deposition.

2 The discharge of the wash load through a reach depends only on the rate at which these particles become available in the catchment and not on the transport capacity of flow.

3 Wash load is generally expressed in mass or volume per unit of time.

7.10 Sediment Concentration — Proportion by mass or volume of the dry sediment in a water-sediment mixture to the total mass or volume of the mixture.

7.11 Mean Suspended Concentration Time-Weighted-Mean-Suspended-Concentration (time-related) — Average of sediment concentration over time.

7.12 Average of the Suspended Concentration (area-related) — Average of the suspended concentration over the cross-sectional area of a channel.

7.13 Specific Mass — Ratio of the mass of a given volume of the sediment to the mass of an equal volume of water.

7.14 Bulk Density (deposited sediment) — Total dry mass of a unit volume (including pores) of undisturbed deposit.

7.15 Oden Theory — Principle, for uniformly dispersed sediment systems, which postulates that the sediment concentration at any level remains constant until the largest particle in suspension has had time to settle from the surface to the level in question.

7.16 Integration Method (sediment transport) — Method of sampling in which the sampler, held stationary at a point, is filled with a water-sediment mixture to almost its full capacity during a sampling period.

NOTE — Suspended-sediment sampling can be made with respect to time as well as with respect to space. When it is made with respect to time, the method is termed "time integration". Mathematically, it can be explained as:

$$\bar{g}_s = \frac{1}{T}\int_0^T g_s \mathrm{d}t$$

where

$\bar{g}_s$ = average sediment transport rate,

T = time interval of integration, and

g_s = instantaneous transport rate.

7.17 Depth Integration Method — Method of sampling suspended sediment in which, by traversing the depth of the stream both in the downward and upward directions at a uniform speed, the sampler takes, at every point on the vertical, a small specimen of the water-sediment mixture, each increment of which is proportional to the local sediment discharge, so that the sampler is filled with a water-sediment mixture that is adequate for sample analysis without overfilling.

7.18 Direct Method of Measurement — Method in which the time-average suspended- sediment load at a point is measured directly.

Example:

One way of measuring directly is by using a point-integrating isokinetic sampler.

7.19 Indirect Method of Measurement — Method in which the time-average concentration of the sediment and the time-average current velocity at a point are measured practically simultaneously with the aid of separate devices.

NOTE — The two values are multiplied together to obtain the sediment discharge.

7.20 Sedimentation Method — Method of obtaining the sediment concentration in a sample containing suspended sediment by letting the sample stand undisturbed so that the sediment settles out from suspension, then successively decanting the sediment-free liquid and ultimately allowing the sample to dry by evaporation.

7.21 Filtration Method — Process of passing a water-sediment mixture through a filter paper or other filtering medium for the removal of suspended or colloidal material.

7.22 Hydrometer Method — Method of estimating the total concentration of suspended load and dissolved matter from the density indicated by a hydrometer.

7.23 Gravimetric Method — Method of estimating the total sediment by allowing the sediment to settle in a container, with a suitable additive to hasten settling, siphoning off the supernatant water and carefully transferring all the sediment from the container to a beaker and from the beaker to a filter paper, then drying the sample and determining the mass of total sediment.

7.24 Pipette Method — Analysis of very fine particles of sediment (less than 0.32 mm in diameter) by sampling with a pipette.

7.25 Fall Velocity, Settling Velocity — Limiting velocity reached asymptotically by a particle falling under the action of gravity in still water.

7.26 Size Distribution — Numerical or graphical representation of the results of a particle size analysis.

7.27 Particle Size Distribution, Grain Size Distribution — Proportion by mass of each particle size present in a given sediment sample.

7.28 Hydrometer — Device, based on *Archimedes' principle,* used for determining the relative density of a liquid and often used to determine the relative abundance of fine (<0.063 mm) particles in a sediment sample.

7.29 Siltometer — Instrument that separates into different sizes the particles of a sample of sediment, either by deposition through a water column or by means of an air current, and measures the volume or mass of the different grades thus separated.

7.30 Bottom Withdrawal Tube — Instrument for analysis of sediment particles of less than 0.5 mm in diameter, based on the principle that in an uniformly dispersed suspension (such as used in the bottom withdrawal tube), the sediment concentration at any level remains constant until the largest particle has had time to settle from the surface to the level in question.

7.31 Sedimentation Tube — Basic component of many items of equipment through which particles settle in a column of liquid, usually water.

7.32 Pycnometer — Instrument for measuring the specific mass of liquids and solids.

7.33 Depth-Sampler — Instrument that obtains a sample of the sediment-water mixture while it is moved vertically at a uniform rate through a given distance in a column of moving water.

7.34 Instantaneous Sampler — Instrument that attempts to trap instantaneously a sample of sediment-water mixture.

7.35 Point-Sampler — Instrument that obtains a sample of sediment-water mixture at a given point over a fixed period of time.

7.36 Pumping Sampler — Instrument that consists of a pumping system with the intake usually perpendicular to the stream flow and the outlet leading to a container or a flushing system.

7.37 Particle Size, Grain Size — Dimension that is representative of the size of an individual particle.

7.38 Mean Particle Diameter — Arithmetic mean of the individual particle diameters.

7.39 Median Particle Diameter, D_{50} — Particle size of a given sample such that the mass of particles of larger diameter are equal to the mass of particles of smaller diameter.

7.40 Geometric Mean Particle Diameter $\overline{d}_g$ — Diameter whose logarithm is the mean of the logarithms of the individual particle diameters.

$$\log_{10} \overline{d}_g = \frac{\sum \rho_i \log_{10} \overline{d}_i}{\sum \rho_i}$$

where ρ_i is the probability or percentage of a sample having a particle diameter d_i.

7.41 Nominal Diameter — Diameter of a sphere of the same volume as the given particle.

7.42 Projected Diameter — Diameter of a circle that circumscribes the projected image of the particle when viewed in the plane of maximum stability.

7.43 Sedimentation Diameter — Diameter of a sphere of the same specific mass and the same terminal settling velocity as the given particle in the same sedimentation fluid.

7.44 Sieve Diameter — Length of the side of the smallest square opening through which the particles will pass.

7.45 Baseline — Line established in a triangulation survey for reference, coordination and correlation.

NOTE — This is the only line whose length is actually measured in the survey: the accuracy of the survey will depend on the accuracy of measurement of this line.

7.46 Full Reservoir Level — Level corresponding to the gross storage which includes both the dead and live storages, but does not normally include additional flood storage.

7.47 Horizontal Control — Basic framework of points whose horizontal position, azimuth and interrelationship have been determined accurately.

7.48 Normal Ponded Reservoir — Storage reservoir normally ponded up to full reservoir level.

7.49 Range Line — Line joining the ranging rods, in a survey.

7.50 Ranging Rod — Rod (2 m or 3 m long), painted in two or three colours, and shod with iron shoes, used to mark stations or other points in a survey so that straight lines may be laid out over the ground and chained if necessary.

7.51 Reservoir — Naturally-occurring space (such as a pond, lake or basin) or man-made construction intended for storage, regulation and control of water.

7.52 Rate of Sedimentation of Reservoir — Annual or periodic reduction in the capacity of a reservoir caused by the deposit of suspended loads and bed loads in the reservoir.

7.53 Reservoir Delta — Delta formed by a river discharging into a reservoir, causing sediment deposition where the river enters the reservoir.

7.54 Trap Efficiency of Reservoir — Ratio of sediment retained in the reservoir to the sediment brought in by the streams.

7.55 Vertical Control, Level Control — Series of benchmarks or other points of known elevation established throughout an area.

7.56 Sediment Material — Sediment (clay, silt, sand, gravel, cobble or boulder) as classified by particle size range in accordance with Table 1.

Table 1 Particle Size Ranges for Sediment Materials

(*Clause* 7.56)

Material (1)	**Particle Size Range,** mm (2)
Clay	<0.002
Silt	>0.002 to <0.075
Sand	>0.075 to <4.75
Gravel	>4.75 to <80
Cobbler	>80 to <300
Boulder	>300

7.57 Bed-Load Transport Model — Physical or numerical model of hydraulic and sediment variables which can be used to predict the bed-load transport rates of sediment along the channel bed.

7.58 Bed-Sampler Efficiency — Ratio of the quantity of sediment trapped in a bed-load sampler to the quantity of the sediment in the stream that would be transported as bed load through the width of the flow occupied by the intake of the sampler, without the sampler in position.

7.59 Weathering — Process of rock breakdown and decomposition instigated by external agencies, such as wind, rain, change in temperature and vegetation.

7.60 Point-Method — Method of sampling of suspended sediment in which the sampler, held stationary at a point, is filled at stream velocity to almost its full capacity during the sampling period with water-sediment mixture.

NOTE — Prior to allowing filling, it is necessary to equalize the pressure inside the sampler with the water pressure at the point of sampling.

7.61 Time-Method — Method of sampling of suspended sediment with respect to time, expressed as follows:

$$\overline{g}_s = \frac{1}{t_i}\int_0^{t_i} g_s \, dt$$

where

$\overline{g}_s$ = sediment transport mean flow rate,

t_i = time interval of integration, and

g_s = instantaneous transport flow rate.

7.62 Range Pillar — Pillar erected at locations around the shoreline of a reservoir to identify the cross-section selected for conducting sedimentation surveys.

7.63 Sedimentation — Aggregate result of five sediment processes (deposition, entrainment, erosion, transport and compaction).

Example :

Weathering and detachment.

7.64 Bed Load Rate — Rate of bed load movement, expressed in mass of volume of bed load transported over the entire width of the river bed and per unit time.

7.65 Isokinetic — Condition where the intake velocity of the suspended-sediment sampler equals the ambient velocity.

7.66 Single-Sampler — Combination of a sample bottle, stopper, and intake and exhaust tubes for collecting a suspended-sediment sample during the rising stage of a stream or river.

NOTE — This device is useful in obtaining sediment data on streams where remoteness of site location and rapid changes in stage make it impractical to use a conventional depth-integrating sampler.

7.67 Fixed-Pumping Sampler — Pumping sampler that automatically collects a water-sediment mixture from a fixed point in a stream or river.

7.68 Moveable-Sampler — Pumping sampler operated from a fixed platform, float or boat for collecting large-volume water-sediment mixtures.

8 UNCERTAINTIES IN HYDROMETRIC DETERMINATIONS

8.1 Resolution — Quantitative expression of the ability of an indication device to distinguish meaningfully between closely adjacent values of the quantity indicated.

8.2 Precision — Closeness of agreement between the results obtained by applying the experimental procedures several times under prescribed conditions.

NOTE — The smaller the random part of the experimental errors which affect the results, the more precise the procedure.

8.3 Average Value $\overline{x}$ — Arithmetic mean of n readings of the value x.

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

8.4 Sensitivity Coefficient, Influence Coefficient θ_x — Ratio of the change in a result, R, to a change in an input parameter, x.

$$\theta_x = \frac{\Delta R}{\Delta x}$$

NOTE — In relative terms, this becomes.

$$\theta_x = \frac{\Delta R / R}{\Delta x / x}$$

8.5 Frequency Distribution — Relationship between the measured values of variables and their frequency of occurrence.

8.6 Population — Totality of items under consideration.

8.7 Sample — One or more items taken from a population and intended to provide information on the population and, possibly, to serve as a basis for a decision concerning the population or the process that produced it.

8.8 Sample Size, n — Number of items included in the sample.

8.9 True Value — Value which characterizes a quantity perfectly defined in the conditions that exist when that quantity is considered.

NOTE — It is an ideal value which can be determined only if all causes of measurement error are eliminated.

8.10 Degree of Freedom, v — Number of terms in a sum minus the number of constraints on the terms of the sum.

Example :

The standard deviation is said to have (n - 1) degrees of freedom because it is necessary to use one degree of freedom to estimate the mean, an element of the equation for the standard deviation.

8.11 Deviation — Difference between the value of a quantity and a standard reference value.

NOTE — Particularly in statistics, the reference value is frequently the arithmetic mean of a series of measurements.

8.12 Experimental Standard Deviation, S — For a series of n measurements of the same measurand, the parameter characterizing the dispersion of the results.

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i - \overline{x})^2}{n-1}}$$

where

x_i = result of the i th measurement, and

$\overline{x}$ = arithmetic mean of the n results considered.

NOTES

1 The experimental standard deviation should not be confused with the standard deviation σ of a population of size N and of mean m, given by the following formula:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - m)^2}{N}}$$

2 If the series of n measurements is considered to be an example of a population, s is an estimate of the population standard deviation.

8.13 Experimental Standard Deviation of the Mean, $s(\bar{x})$ — Estimate of the standard deviation of the arithmetic mean $\bar{x}$ calculated from a sample of n measurements with respect to the mean m of the overall population.

$$s(\bar{x}) = \frac{s(x)}{\sqrt{n}}$$

8.14 Experimental Variance, s^2 — Measure of the scatter or spread of a distribution, estimated by calculating the sum of the squares of deviations of measurements about the means, divided by the number of degrees of freedom.

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

8.15 Residual Variance, s_R^2 — Square of the standard error of estimation.

8.16 Weight of Measurement, w_i — Number which expresses the degree of confidence in the result of a measurement of a certain quantity, in comparison with the result of another measurement of the same quantity.

8.17 Arithmetic Weighted Mean, Weighted Average, $\bar{x}_w$ — Sum of the products of each value and their weight of measurement divided by the sum of the weights of measurement.

$$\bar{x}_w = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$

8.18 Calibration — Process of comparing the response of a measuring device with a calibrator or a measuring standard over the measurement range.

8.19 Calibration Hierarchy — Chain of calibrations which link or trace a measuring device to a primary standard.

8.20 Normal Distribution, Laplace-Distribution — Probability distribution of continuous random variable x such that the probability density is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{x-m}{\sigma}\right)^2\right]$$

where

m = arithmetic mean, and

σ = the standard deviation of the normal distribution.

8.21 Method of Least Squares — Technique used to compute the coefficients of an equation, when a particular form of equation is chosen for fitting a curve to data.

NOTE — The principle of the method of least squares is to minimize the sum of squares of deviations of the data from the curve.

8.22 Regression — Process of quantifying the dependence of one variable on one or more other variables.

8.23 Least-Regression — Procedure for determining the unknown constants of a proposed model in such a manner that predictions from the model are as close as possible to the data.

NOTE — "As close as possible" is taken to mean that the sum of squares of the deviation is a minimum.

8.24 Error of Measurement — Result of a measurement minus the true value of the measurand.

NOTES

1 The term relates equally to

— the uncorrected result, and

— the corrected result.

2 The known parts of the error of measurement may be compensated by applying appropriate correction. The error of the corrected result can only be characterized by an uncertainty.

8.25 Absolute Error of Measurement — Result of a measurement minus the conventional true value of the measurand.

NOTES

1 The term relates equally to

— the uncorrected result, and

— the corrected result.

2 The known parts of the error of measurement may be compensated by applying appropriate corrections. The error of the corrected result can only be characterized by an uncertainty.

3 "Absolute error" which has a sign, should not be confused with "absolute value of an error" which is the modulus of an error.

8.26 Outlier — Observed value in a set of data which appears to be inconsistent with the remainder of the set of data.

8.27 Spurious Error — Error which invalidates a measurement

NOTE — This type of error generally has a single cause, such as the incorrect recording of one or more significant digits or the malfunction of instruments.

8.28 Random Error — Component of the error of measurement which, in the course of a number of measurements of the same measurand, varies in an unpredictable way (*see* Fig. 24).

NOTE — It is not possible to correct for random error.

8.29 Systematic Error — Component of the error of measurement which, in the course of a number of measurements of the same measurand, remains constant or varies in a predictable way (*see* Fig. 24).

NOTE — Systematic errors and their causes may be known.

8.30 Elemental Error — Random or systematic error associated with a single source or process in a chain of sources or processes.

8.31 Standard Error of Estimation, Residual Standard Deviation, s_R Measure of dispersion of the dependent variable (output) about the least-squares line obtained by curve fitting or regression analysis.

$$s_R = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \bar{y})^2}{n-k}}$$

where

n = number of data points, and

k = number of coefficients in the equation.

NOTES

1 This equation is similar to the expression for standard deviation, except that the curve-fit value, $\bar{y}$, replaces the mean value, $\bar{x}$, and k replaces 1.

2 The number of coefficients, k, is equal to the number of explanatory variables plus one (to include the intercept).

8.32 Confidence Limits — Lower and upper limits within which the true value is expected to lie with a specified probability, assuming negligible systematic error.

8.33 Confidence Level — Probability that the true value will lie between the specified confidence limits, assuming negligible systematic error.

NOTE — The confidence level is expressed as a percentage.

8.34 Student's Distribution, Student's *t* Distribution, t — Distribution of the deviations of the mean values of the samples from the population means.

Example :

$(e_r)_{95} = t_{95}{}^s$

where

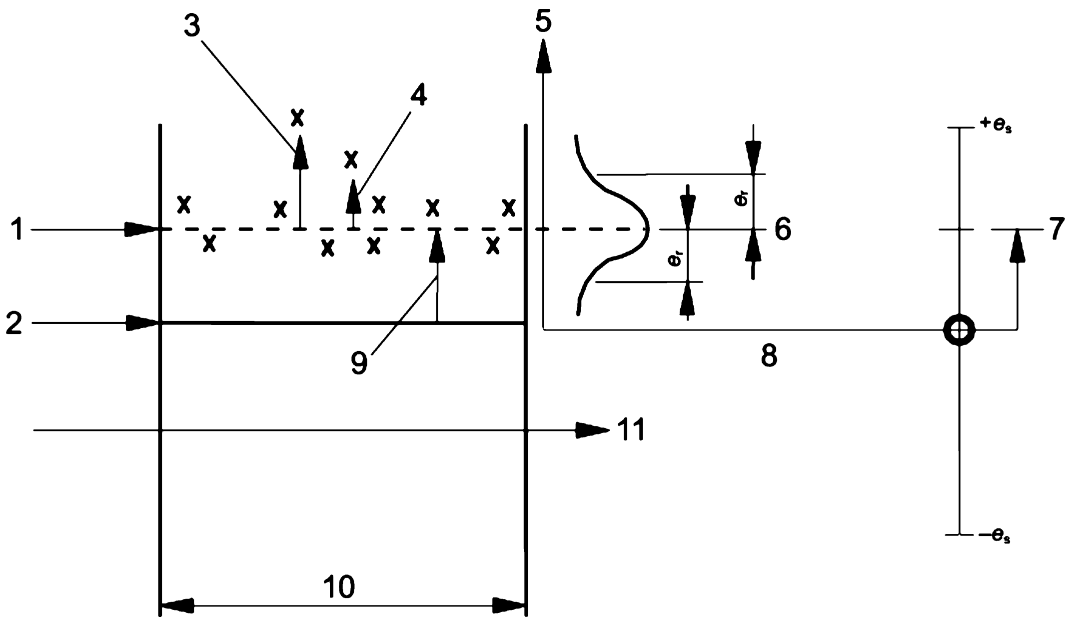
$(e_r)_{95}$ = random uncertainty at the 95 percent confidence level;

t_{95} = appropriate value of Student's t distribution;

s = sample standard deviation.

NOTE — Student's distribution is used to set the confidence limits of the population mean, in particular in cases where the mean has been estimated from small samples. It is obtained from tables giving the number of degrees of freedom and the confidence level, where

$$t = \frac{\bar{x} - \mu}{s\sqrt{N}}$$



Key

1 — mean measured value of quantity
2 — true value of quantity (unknown)
3 — spurious error
4 — random error
5 — value of measured quantity
6 — random uncertainty, e_r, assessed with specific confidence level
7 — systematic error, e_s, unseen within limits
8 — probability density
9 — systematic error
10 — time during which a constant value of the quantity Y is being assessed
11 — time

FIG. 24 DIAGRAM ILLUSTRATING THE TERMS RELATING TO ERRORS AND UNCERTAINTIES

where

m = population mean.

8.35 Uncertainty, u — Estimate characterizing the range of values within which the true value of a measurand lies.

8.36 Random Uncertainty, e_r — Component of uncertainty associated with a random error (*see* Fig. 24).

NOTE — Its effect on the mean value can be reduced by taking many measurements.

8.37 Systematic Uncertainty, e_s Component of uncertainty associated with a systematic error.

NOTE — Its effect cannot be reduced by taking many measurements.

8.38 Accuracy — Qualitative expression for the closeness of a measured value to the true value.

NOTE — The quantitative expression of accuracy should be in terms of uncertainty. Good accuracy implies small random and systematic errors.

8.39 Standard Uncertainty — Uncertainty of the result of a measurement, expressed as a standard deviation.

8.40 Type A Evaluation of Uncertainty — Evaluation of a component of measurement uncertainty by a statistical analysis of measured quantity values obtained under defined measurement conditions.

8.41 Type B Evaluation of Uncertainty — Evaluation of a component of measurement uncertainty determined by means other than a type A evaluation of measurement uncertainty.

8.42 Expanded Uncertainty — Quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the values that could be attributed to the measurand.

8.43 Combined Uncertainty — Standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities.

8.44 Coverage Factor — Numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty.

8.45 Level of Confidence — Percentage of instances that a set of similarly constructed tests will capture the true mean.

ANNEX A

(*Normative*)

SYMBOLS USED IN HYDROMETRY

Term	Symbol	Dimensions	Sl units
Acceleration due to gravity	g	LT^{-2}	m/s^2
Adjustment factor	k	a	a
Angle	α	b	rad
Area	A	L^2	m^2
Average value	$\overline{x}$	a	a
Boundary layer displacement thickness	δ	L	m
Breadth (width) (partial)	B	L	m
Bulk (or volume) modulus of elasticity	K	$ML^{-1}T^{-2}$	Pa
Chezy coefficient	C	$L^{1/2}T^{1}$	$m^{1/2}/s$
Concentration	C	ML^{-3}	mg/l
Constant	K	a	a
Conveyance	K	L^3T^{-1}	m^3/s
Coordinate	x, y, z	L	m
Correction factor for measured discharge in open channels	F_m	a	a
Depth	D	L	m
Diameter	d	L	m
Difference between two values of the same quantity	Δ	a	a
Dilution ratio	N	b	b
Dimensional sensitivity coefficient	θ	a	a
Discharge	Q	L^3T^{-1}	m^3/s
Dynamic viscosity	η, μ	$ML^{-1}T^{-1}$	Pa·s
Effective roughness height	k	L	m
Efficiency	η	b	b
Electrical resistance	R	$ML^2T^{-3}I^{-2}$	Ω
Energy correction factor (Coriolis energy coefficient)	α	b	b
Equivalent sand roughness	k_s	L	m
Experimental standard deviation	s	a	a
Experimental standard deviation of the mean	$s(\overline{x})$	a	a
Experimental variance	s^2	a	a
Force, pull or thrust (tension)	F	MLT^{-2}	N
Frequency	f	T^{-1}	Hz
Friction factor	f	b	b
Froude number	Fr	b	b
Geometric mean particle diameter	d_g	L	m
Head loss per unit length	ς	b	b
Total head, energy head	H	L	m
Height of flume invert	p	L	m
Height of weir	p	L	m
Hydraulic mean depth	r_a	L	m

Term	Symbol	Dimensions	Sl units
Hydraulic radius (hydraulic mean depth)	r_h	L	m
Kinematic viscosity	v	L^2T^{-1}	m^2/s
Length	l	L	m
Length (partial)	l	L	m
Loss of head per unit length (or hydraulic gradient)	i	L	m
Manning coefficient	n	$L^{-1/3}T$	$s/m^{1/3}$
Mass	m	M	kg
Mass per unit volume (density or specific mass)	ρ	ML^{-3}	kg/m^3
Measured value	M	a	a
Number of degrees of freedom	v	a	a
Number of measurements in a set	n	b	b
Number of sources of error in a result	k	b	b
Particle diameter	d	L	m
Percentage error of x	X	b	b
Power	P	ML^2T^{-3}	W
Pressure	P	$ML^{-1}T^{-2}$	Pa (or N/m^2)
Probability	p	b	b
Radian measure	p	b	rad
Radius	r	L	m
Rate of injection of chemical tracer	q	L^3T^{-1}	ml/s
Rate of sampling	q	L^3T^{-1}	ml/s
Residual standard deviation	s_R	a	a
Residual variance	s_R^2	a	a
Result of a measurement	R	a	a
Reynolds number	Re	b	b
Rotation speed	n	T-1	rad/s
Sample size	n	a	a
Sensitivity coefficient	θ_x	b	b
Shape factor	Z	b	b
Shear stress	τ	$ML^{-1}T^{-2}$	Pa (or N/m^2)
Side slope	m	b	b
Slope, bed slope	S	b	B
Specific discharge	q	L^3T1	m^3/s
Standard deviation	σ	a	a
Student's t distribution	t	b	b
Sub-area	A	L^2	m^2
Surface tension	σ, γ	MT^{-2}	N/m
Temperature (Celsius)	θ, τ	θ	°C
Thermodynamic temperature	Θ	Θ	K
Thomson's T	τ	b	b
Time	t	T	s
Total head, energy head	H	L	m
Total breadth (width) of the channel	B	L	m

Term	**Symbol**	**Dimensions**	**Sl units**
Transmissivity	T	L^2T^{-1}	m^2/s
Uncertainty	u	a	a
Uncertainty in a result (with various subscripts)	e	a	a
Unit discharge	q_u	L^2T^{-1}	m^2/s
Variable quantity	x	a	a
Velocity	v	LT^{-1}	m/s
Volume	V	L^3	m^3
Wave celerity, propagation velocity	C	LT^{-1}	m/s
Wavelength	λ	L	m
Weber number	We	b	b
Weight	W	MLT^{-2}	N
Weight of measurement	w_i	a	a
Weighted average	$\bar{x}_w$	a	a
Wetted perimeter	P_w	L	m
x velocity component	u	LT^{-1}	m/s
y velocity component	v	LT^{-1}	m/s
z velocity component	w	LT^{-1}	m/s

NOTES

1 The above symbols, except when otherwise stated, are indicated in their most general form. For any specific use, such symbols may bequalified by a subscript, where necessary, and explained to indicate the exact meaning.

2 The subscripts "1" and "2" are used to indicate "upstream" and "downstream" respectively.

a—Dimensional order depends on its meaning in context.

b—Non-dimensional quantity.

Alphabetical Index

T

U

V

W

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